PAIN

ITS ORIGIN, CONDUCTION, PERCEPTION AND DIAGNOSTIC SIGNIFICANCE

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WITH ONE HUNDRED AND NINETY-ONE
ILLUSTRATIONS IN THE TEXT AND
MANY DIAGNOSTIC CHARTS

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IT IS WITH THE GREATEST OF PLEASURE
THAT I DEDICATE THIS BOOK TO ONE
WHO HAS EVER BEEN AS A FATHER
TO ME AND TO WHOM I OWE THE
MOST OF WHAT I AM—TO MY UNCLE
MALACHY O'DONNELL

BENGAL ALLEN HOMOEOPATHIC MEDICAL COLLEGE • CALCUTTA •

PREFACE

During many years I have been impressed with the necessity of a thorough understanding of pain phenomena in the making of a diagnosis. Pain is universal, and is present in practically every disease, and in most diseases it is the *one* symptom which first attracts the patient's attention and causes him to become aware of some change in his physical well-being. The patient then comes to the physician, who, unless he is well versed in the interpretation of pain phenomena, may be at a loss to interpret the symptoms which are presented to him. To do so he needs to know not only the various factors to which a certain pain may be due, but also the reasons why it should be produced and the different diseases giving rise to pain of similar character and location. To understand thoroughly these latter factors the physician must needs be versed in all the essentials and components of which a pain consists, its causes, character, varieties, its localizations and the changes induced by its presence.

It was with the idea of supplying easily accessible information along these lines that I undertook the composition of this book. To those, who, like myself, have felt the need of such a book, I offer it with the hope that it may be of some help to them. To make it as complete as possible has been my endeavor, and to do so I have thoroughly searched the literature and culled from it all that I thought might be of use. I believe credit has been given in all cases to the authors of my references, but if, through an unintentional oversight, this has been neglected, I beg that my attention may be called to it so that it can be remedied.

It is with the greatest pleasure that I express my thanks to Dr. T. L. Disque, Dr. Wm. H. Glynn, Dr. E. C. Stuart, who so kindly granted me the use of an abundant material from his surgical service; to Goldsmith of Vienna, who reviewed the anatomical section of my work; to Dr. Frankel of the same city, who reviewed my gynecology section; to Dr. Smith Ely Jelliffe, who has reviewed the entire work; to Mr. Sander of Vienna; and Dr. Frenzel and Dr. Powers of Berlin; to Miss Esther Hrubesky of Berlin, who has aided me in revising my proofs and illustrations.

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7-8-28

PAIN

CHAPTER I

GENERAL CONSIDERATION OF SENSATION

To those who are interested in the study of disease, it is scarcely necessary to emphasize the value of the correct appreciation of pain as a symptom. The importance of its interpretation must be obvious. Almost ninety per cent. of all diseases either begin with, or have, pain as a prominent symptom at some time during their course. Therefore, a correct diagnosis can hardly be made without an intensive study of the various forms of pain.

Sensation in Lower Animals.—We may, therefore, take up with profit a consideration of sensation, of which pain, as a psychological entity, is but a part. In fact, to gain a comprehensive idea of pain, it is necessary to begin our studies with those organisms in which sensation emerges from that simple state in which all stimuli are responded to by reflex protoplasmic movements, of which the organism has no perception.

This movement according to Loeb would be the result of chemotropism. All protoplasm is attracted by certain substances and repelled by certain other substances, the attraction and repulsion depending upon the construction of the protoplasm and the stress of its need or avoidance of the constituents of which the other body is composed. Such a state we find in the ameba. In a higher organism, as the medusa, an aggregation of cells possesses the same threshold of irritability for certain substances and thus they respond to irritation by coördinated motion and this seems to be due to the presence or absence of certain ions in the stimulating substance. (Na ions start or increase rhythmical contractions; Ca diminish the rate or inhibit such contractions.) Or should the cells all not come into contact with the exciting factor, the one coming into contact can transmit its stimulus to other adjacent cells and in them produce a similar reaction to its own.

This propagation by contraction is better exampled in the Ciona intestinalis, where as a means of communication a set of cells are specially differentiated so that they can better and more quickly carry stimuli from one structure to another. In other words, conduction is their function. These cells arrange themselves into special groups, etc., and form what is termed the nervous system. But in the lowest forms of life the nervous system is not a necessity, but only an auxiliary in the life economy of the animal, as demonstrated by Loeb. He removed the central nervous apparatus of the Ciona intestinalis and found that it still responded to a mechanical stimulus of one group of muscles by contraction of other groups, but that this response was much slower than when the central nervous system was intact. From this he concluded that while the central nervous system was not absolutely necessary (in this animal) still it served a useful purpose in that the stimuli were conducted more quickly and that therefore the threshold of response was greatly lowered. In the earthworm, which is composed of segments, each segment has its own special nerve supply. Forward motion in this animal is due to the alternate action of the longitudinal and the circular muscles. Friedländer found that removal of its central nervous system had no effect on the coördination of progressive motion. This is explained by Loeb, who says that when the forward piece is elongated and attempts to shorten itself by contraction of the longitudinal muscles, the skin of the aboral piece is stretched and that this stretching produces a stimulus to the longitudinal muscles of the posterior piece which then contracts and causes the animal to move forward. Thus at this stage of biologic advancement, motion is not the result of sensation, but is only a reflex of a very simple nature. In animals of a higher order the same stimulus exists, but the *stimulus of origin* is in some cases far removed from the stimulus of effect. The conduction from place of origin to point of effect being through nerve paths, the motion is still the result of a reflex, and this reflex either causes the animal to move to or draw away from the source of the stimulus either as it is beneficial or destructive to its economy. When it does so withdraw or when it responds to excitor stimuli by rapid and irregular motion, are these an indication of a disagreeable sensation or of pain?

Reaction of Animals to Pain.—Many have assigned to the lower organisms the same pain sensation as that possessed by man. The reason assigned for this hypothesis is that reactions take place to injurious stimulation, by various reflex movements, and that these reflex movements are the motor manifestation of pain. This interpretation is contested by Norman ("American Journal of Physiology," Vol. III, p. 271, 1899), who states that in many animals, ranging from the simple worm to the higher vertebrates, such as fish, he has cut off segments of the body and otherwise insulted the integrity of the structure, without, in some instances, producing any movement at all, or, if movement occurred, without producing any which was greater than that caused by ordinary and slight stimuli. He maintains that the movement of an animal is not due to impulses caused by the sensation which we designate as pain. Should excessive reflex movements be produced, they are the result of an excess of stimuli, not necessarily destructive. His experiments were varied and numerous. In one instance, he cut an earthworm in two; and while the posterior part performed very rapid twisting and squirming movements, the anterior half simply elongated and went on crawling, the same as before the experiment. Is it possible that pain would be felt in the posterior part, and that the anterior segment, in which the main ganglia are located, would be free of pain? Norman elaborated his experiments further. He cut in half a leech, which was swimming in the water, and observed that both segments continued their motion without interruption. Starfish and crabs, as well, showed no reaction to division. He cut away the posterior part of the abdomen of a bee, while it was engaged in sucking honey, without any interruption to its activity. He also mentions the fact that sharks may be cut and operated upon without the slightest movement on their part. Experiments of this nature tend to show that one must ascend rather high in the vertebrate scale before true pain phenomena make their appearance. In fact, it is only in mammals that this sensation is developed to its highest degree. In our study of pain, therefore, we must bear in mind that motor response to an irritant is not always an indication of pain, but is only a reaction to stimuli (not necessarily sensory). However, before proceeding further in our consideration of pain phenomena we shall study sensation and its attributes.

General Consideration of Sensation.—Sensation itself is the perception of an impression conveyed to the brain as the result of the activity of some peripheral sense-organ. These sense-organs may give rise to both subjective and objective sensations. Subjective sensation is the result of activity of those forces of the body which are concerned with its integrity and well-being. It gives rise to hunger, satiety, nausea, thirst, physical or mental depression, or exhilaration, joint sensation, and the like, and may be called an organo-protective sensation. It also produces the feeling of fatigue and exhaustion. Objective sensations primarily depend, for their perception, upon the presence of external receptors, such as those of sight, touch, smell, hearing, taste, temperature, etc. Therefore, in order to have sensation, that is, to be capable of perceiving and interpreting stimuli, and of classifying them under certain empirical divisions as belonging to one domain or another of feeling, it is first necessary that our sense-receptive organs be intact, the sense-conveying organs normal, the sense-interpreting centers active and the associative memory center (consciousness) intact. Should the latter be disturbed, as occurs during certain mental diseases, anesthesia, etc., sensory stimuli, irrespective of their character, either will fail to be perceived, or, if they are, will be greatly modified. Since we speak of consciousness it may be well to briefly consider it. It has been defined as the ability, power, faculty, or mental state of being aware of one's own existence, thoughts, feelings, actions and sensations, whether intellectual, moral or physical (Sudduth, 472), and must be present to take up and correlate the different stimuli reaching the brain from the periphery.

Consciousness has been divided into two classes: (a) subjective and (b) objective. Subjective consciousness tells us of things which originate in the mind (we shall have occasion to use this concept later in our study of hysteria). Objective consciousness tells us of things perceived through the senses.

Of the senses we distinguish two varieties, the internal and the external. The internal senses are those which are concerned with the well-being of the organism, and the relation of the different parts, one to another. They include muscle sense, joint sense, hunger sense, etc. The external senses are those which are concerned with the interpretation of external objects, and include, generally speaking, touch, smell, sight, hearing, taste, muscular and temperature sense. Each of these senses has a complete nerve apparatus of its own, consisting of sense-receptive, sense-conveying, and sense-perceptive organs. The sense-receptive organs are the terminal filaments of the sensory nerves. The sense-conveying organs are the axis cylinders of the sensory ganglia cells (the nerves) and the sense-perceptive organs are the sensory cortical cells.

We now have the apparatus; all that is lacking is the force. The question now arises, what is this force, and what varieties of stimuli produce the changes which give rise to sensation? The two most prominent hypotheses are that the stimulus is of a chemical or electrical nature or is a mechanical force in the form of vibration. The chemical hypothesis is that the external stimuli produce some chemical change in the cell, which reaction is propagated into other adjacent cells until it reaches the perceptive center. Engelman (377) advances the idea that the impulse which creates sensation is of an electrical nature, but does not exactly define what he means by electrical nature. By many, however, it is held that all sensation is the appreciation of arrested motion (vibration), this motion being the result of a mechanical, a chemical or an electrical contact. It is the motion of the ether molecules upon the retina which produces the "formation or decomposition of certain substances and it is the chemical processes of the formation and decomposition of these substances which determine light and color sensations" (Loeb, 104 C., p. 291); the motion of the air molecules upon the drum membrane of the ear which "causes vibration in endings of the auditory nerve by which new molecules are brought into contact with each other and sound is produced" (Loeb); the impact of the odoriferous particles upon the olfactory nerve terminals in the mucous membrane of the nose which creates smell (chemical action). For taste, it is essential that the sapid substance shall come in contact with the taste-buds of the tongue (chemical action); for touch, that matter must come in contact with the nerve terminations in the skin. Thus we see that all sensation depends upon contact, and that contact gives rise to motion. This motion is in the form of vibration (molecular), and the sensation produced depends upon the sense-organ against which the vibration impinges. Each terminal sense-organ takes up only the vibrations produced in a particular medium. For instance, in the normal state, sound is perceived only when the air is in vibration against the cochlear apparatus; light depends wholly upon the vibration of the ether upon the retina; smell upon the impingement of minute physical particles upon the olfactory terminals, etc. It is also of great interest to know that the sense perception of these organs in man is limited to the perception of vibrations which lie within certain limits. For example, the human ear is unable to hear if the vibration is below two per second, or greater than thirty-three thousand per second. Thus man is unable to hear the calling of a whale, because the tone of the whale's voice vibrates only two per second; as he also frequently is unable to hear the humming of a swarm of gnats, a sound which is produced by a vibration of about thirty-five thousand per second.

Properties of Sensation.—Sensation possesses the following properties: quality, intensity, and duration.

(1) *Quality* gives us an idea as to the cause of the sensation. For instance, the quality of the sensation of sound is entirely dif-

ferent from that of the sense of taste, and it is this difference which enables us to correctly determine the source of origin (whether from a peripheral sense-organ of taste, hearing, smell, etc.). It also enables one to distinguish variations in the same sensation.

(2) *Intensity* enables us to distinguish differences in the strength of stimuli producing the same sensation, and indicates, also, the receptive state of the organism to the sensation. At certain times pain is much more acutely felt. This is due to the fact that at these times the organism is weaker, being either reduced by exhaustion or disease, and therefore it is more acutely affected by all irritative stimuli.

(3) *Duration* of a sensation depends, first, upon the intensity, and second, on the rapidity of the impulse. If the impulse is very intense, the sensation in the sense-perceiving centers persists for some time after the stimulus has ceased. For example, if a bright light is placed before the eyes, the sensation of light persists for some time after the light stimulus has been removed; also if we gaze at a bright light and then close the eyes, the sensation of light still continues for a few seconds. The rapidity of the repetition of stimuli also influences the duration of the sensation. If the stimulus is repeated too frequently, we find that a continuous instead of an interrupted sensation is felt. This is due to the fact that the sense perception of all stimuli persists for a short time after the stimulus has ceased to exist. Thus, if the stimuli follow each other at short intervals, the sensation is that of a continuous stimulation. At times, remissions in sensation occur, and are due to fatigue of the central sense-perceiving center.

Centers for Sensory Perception and the Sense-Organs.—It has been observed by Goltz, H. Munk and others (Tigerstedt's "Physiology," p. 651), that in the dog the destruction and removal of the motor region and the cortical layers adjacent thereto cause a variety of derangements of sensation and of motion. These cortical layers, then, must in some manner be concerned with the perception of sensation. It has been found that if the entire cortical area for the posterior extremity is removed the muscles of the opposite leg can no longer execute finely graded movements; that for some days after the operation a complete insensibility in this extremity exists; and that a certain bluntness of sensibility becomes permanent.

With still more extensive destruction, the finer movements of the hand and foot are permanently arrested in the monkey, and for some time after the operation the sensitiveness of the paws is somewhat reduced, so that the animal reacts only to very painful stimuli. In fact, the sensitiveness of the hand and foot becomes permanently so slight that a severe pinch produces no reaction at all (Mott). On the other hand, Schaffer has found that a monkey which does not react at all to a painful pinch immediately notices a slight tactile stimulus applied to the paralyzed extremity. The monkey from which Goltz had removed the entire motor region of the left hemisphere took no notice of the gentle tactile stimuli applied to the right extremity. Stronger pressure stimuli were always felt. Motor sensations were also somewhat diminished.

From this it will be observed that generally, except in the case mentioned by Schaffer, in which pain sensation was lost but tactile sensation was present, it will be found that, in case of destruction of the motor area, the sensation in the skin over the paralyzed part will also be reduced for touch, but present for pain. This might be accounted for on three hypotheses: (1) that the impulse which would produce pain is so intense that it spreads over a considerable area of the cortex, and is communicated to parts which are not destroyed and which still have the power of pain perception; or (2) that, owing to the strength and volume of the impulse, it is transmitted to the cortical area in the opposite hemisphere, and is there perceived; (3) that the center for pain sensation is not in the cortex, but lies proximal to it in one of the forwarding structures of the sensory apparatus, namely, in the optic thalamus. The first supposition gives weight to the argument that it is the extent of the cortical reaction which produces the relative sensations, either of touch or of pain, a small area giving rise only to touch, a large area to pain. This possibly

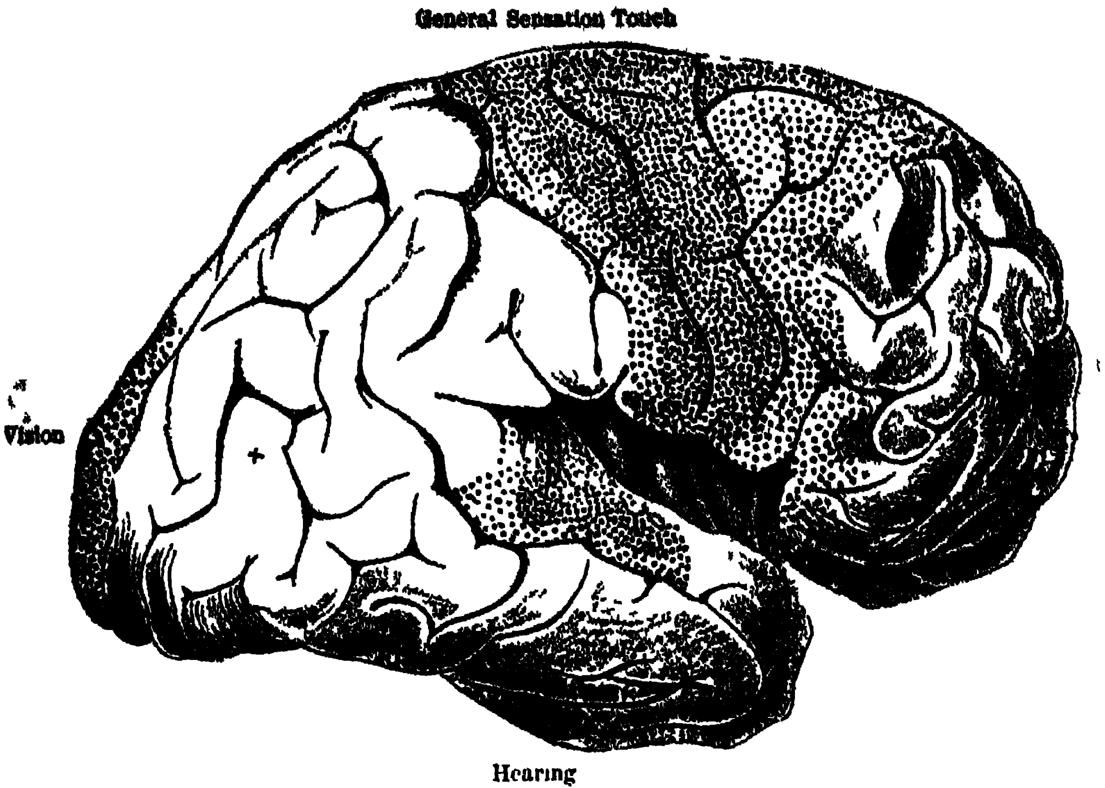

FIG. 1 —RIGHT CEREBRAL HEMISPHERE SEEN FROM THE OUTSIDE.

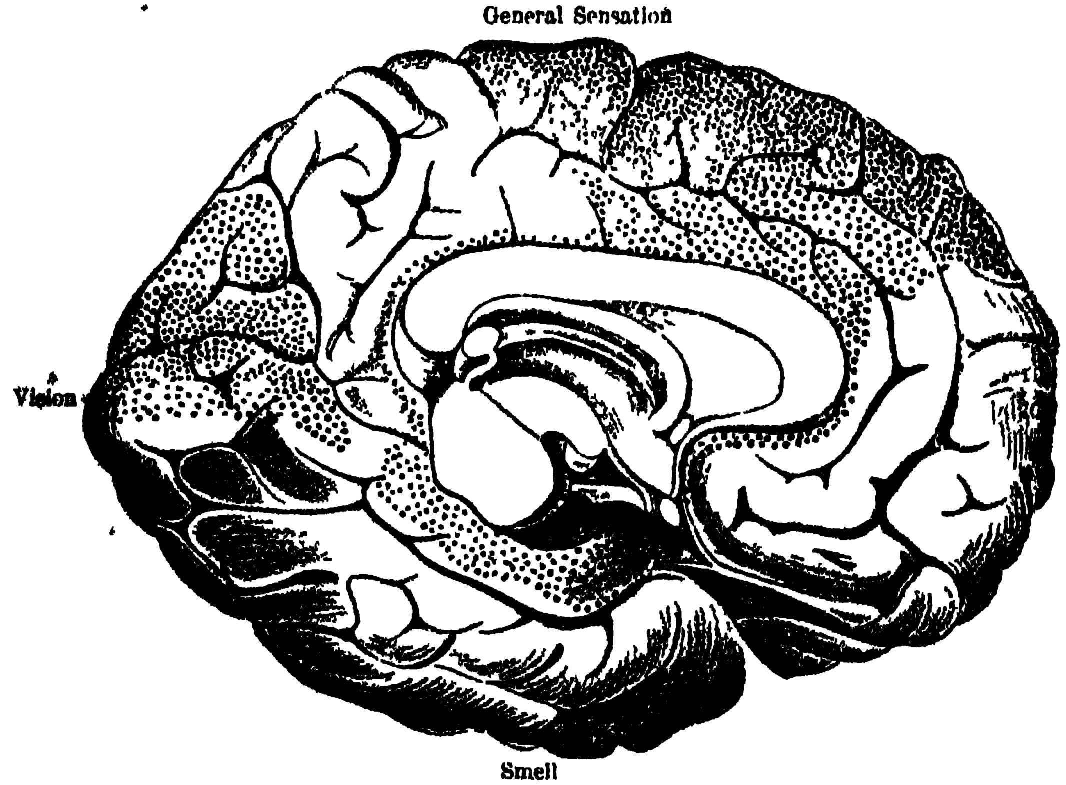

FIG. 2 —INNER SURFACE OF RIGHT CEREBRAL HEMISPHERE.

Figures 1 and 2 show the areas of sensory distribution according to Tigerstedt (p. 654), modified from Flechsig Dots indicate sensory areas. Areas where dots are thickest are the regions where most of the sensory pathways end.

can be explained from the inhibitory action of the cortex, the destruction of a small area being not sufficient to abolish the inhibitory impulses sent from the cortex to the optic thalamus and their acting as controls over the sensory perceptions.

It has been found that general sensation and touch are lost by destruction of the central and parietal convolutions, paracentral lobules, and possibly the posterior part of the frontal convolutions, and that, for the most part, the sensory area consists of post central and parietal convolutions (Leszynsky, 498; May, 397, p. 793).

Many sensory fibers enter the post central convolution. Some also enter the precentral convolution. The first and second frontal convolutions also receive some fibers; they chiefly are, however, sensory fibers connected with the cerebellar system.

Upon destruction of these areas, the different sensations are differently affected, namely: (1) pain sensations suffer least, because a wider area is required for their destruction; (2) pressure and temperature sensations are somewhat reduced, but by no means abolished; (3) power of localization is profoundly affected; (4) motor sensations are much disturbed.

The areas for sensation are probably bilateral in their location. Mills claims that they are also found in the limbic and quadrate lobes. While Dana admits that this is possible, he also holds that the motor areas are also sensory (Church and Peterson, 506, p. 367). The sensorimotor area, in the optic thalamus (the so-called associative memory center of Loeb), is probably a depot for memory of sensation as it passes on its way to higher centers, in the limbic or quadrate lobes.

According to Horsley (ibid., p. 162), the different cell areas for motion and sensation are superimposed in strata. Most superficially the tactile sense, then the muscular sense, and finally the pure motor sense elements are found. It appears that in these areas the granular cells are the active agents in sensory perception, since lesions in this cell layer cause disturbances of touch, pressure, localization, muscular sensibility (sense of passive position and of movement), and, less frequently, of pain and temperature. This disturbance occurs in the opposite side of the body, and, when a limb is involved, the sensation is first lost in, and is last to return to, the distal portion and outer margin (W. Page, May, 397, p. 796).

The small pyramidal cell layer may also be concerned indirectly in pain production, since these cells are atrophied in dementia, and may, therefore, be indirectly associated with sensibility; because it has been found that sensibility varies almost directly in proportion to the mental development of the individual, and that the pyramidal cells vary directly in proportion to the mentality.

It has also been claimed that the cerebellum is the seat of all pleasure and pain activities (F. Courmont, "Le Cervelet et ses Fonctions"), and also of those connected with the emotions (Marshall, p. 25). Modern anatomical research, however, has shown that the cerebellum is the chief central organ for the senses of equilibrium, muscle tonus, and orientation in space. And although it is preeminently a sensory organ, the cortex being a sensory cortex, it is not such for pain, for light touch, heat, or cold.

Sense Perceptive Organs. Recently the sense-organs, the stimulation of which causes sensation, have been divided into three classes: (1) the visceral sense-organs of the internal organs and their derivatives, (2) the exteroceptor, or somatic, sense-organs, which receive the impressions from the outer world, and (3) the proprioceptors, which receive impressions from the muscles, tendons, etc., and report to the sensory area the exact position of the body and the relationship of parts to each other.

The researches of Head, Holmes, and Sherrington have served to show that the constituents of sensation are extremely complex. So far as the visceral receptors are concerned, we know very little about them. There are chemical, touch, heat, and cold receptors, and undoubtedly receptors which have to do with the forces of gravity. Most of these receptors Head has placed within his protopathic system. They belong, phylogenetically speaking, to old systems; are almost automatic, and for the most part are passed over to the autonomic sympathetic nervous system. Their spinal representations are present largely in the lateral processes of the cord. Their central paths are not as yet definitely determined.

The *extroceptor or somatic sense organs* are divided by Head into the *epicritic* and *protopathic* systems. The ability to distinguish light touch (cotton wool), two points of a compass (at small intervals varying with the part), and to discriminate slight variations in temperature, are held by Head to be specific and individual entities. Together they constitute his epicritic system. Their spinal, medullary, thalamic, and cortical distributions have been fairly well defined. To the protopathic system on the other hand belong the faculties to distinguish ordinary touch, deep pressure, extremes of heat and cold. Finally, according to Sherrington, there exists another system, the *proprioceptive*. Its receptors are found in many places in the body, chiefly in the tendons, muscles and bones, and also most characteristically in the labyrinth. Its chief sensations are those connected with the orientation of the body in space; the vestibular nerve being its chief cephalic ganglion and the cerebellum its chief central organ.

Stimuli.—The stimuli necessary to produce a sensory-reaction may be mechanical, chemical, thermal or electrical. Any of these, when applied in normal quantity, and with normal force, produces a normal reaction; but when applied with excessive intensity, all are capable of stimulating the specific pain receptors.

Interpretation of Sensation.—If we consider for a moment the embryological development of the human body, we find that the external organs of sensation develop *pari passu* with the internal organs, but that the external ones are practically without function until the fetus is born. During the period of intrauterine existence, the external senses are lying dormant; but as soon as the fetus is born, and feels the touch of air upon its surface, it has entered upon a new life, and one vast complex of sensations reaches it from every side. Embryologically the vestibular system develops very early.

These sensations are for three purposes: (1) to provide protection for the organism; (2) to provide for its development; and

(3) to provide for its reproduction. We find that in general everything which reacts unfavorably to the organism causes distasteful and disagreeable sensations. These, when of a peculiar quality and intensity, give rise to the sensation which we term *pain*. It is also found that everything which acts or aids in the growth, development and reproduction of the organism causes pleasure. Between the two extremes of pain and pleasure there exists a neutral state, where, because of the weakness of sensory stimulation or perception, a state neither of pleasure nor of pain is produced. This we term the *state of indifference*. Therefore, we may be said to have three states of sensory mental activities, namely, pain, indifference and pleasure.

DEFINITION OF PAIN.—*Pain* is distinctly a mental interpretation, and cannot be strictly defined. It is the interpretation of some abnormal and generally harmful process which is occurring in the organism. It cannot be classed as a sensation, but rather is the result of the perception and interpretation of sensation by the mind. Our consideration of pain will naturally lead us into a discussion of its antithesis, pleasure, since the two are intimately connected in their perception and in their interpretation. Both are the result of mental activity.

MENTAL ACTIVITY.—According to many authors, three divisions of mental activity have been assumed: intellect, or the faculty of thought; sensibility, or the faculty of feeling, and volition, or the faculty of voluntary action. This is manifestly a purely artificial division. While we are primarily interested with the second division, it is my purpose to show that it is intimately bound up with the first (intellect). I shall also point out that the intellect can, by the exercise of memory, recall to mind the objective sensations classified as pain, and, by making them pertinent to the moment, cause them to appear real, as if experienced at the time. In other words, intellect is able to produce, without any objective means, the sensation of pain. This class of pain-sensation, which seems to appear without any definite causative factor, is frequently called subjective pain.

The crudest mental impressions consist of the primary sensations of touch, sight, hearing, taste, smell, and temperature, which are objective, and muscle sense, joint sense, hunger sense, etc., which are subjective. These, when carried to and interpreted by the brain, result either in pleasure sensation, neutrality, or pain; and as a result of these mental interpretations there arise certain mental states, such as joy, sadness, pleasure, and happiness, which in turn may give rise to mental activities, such as anger or its converse.

Mental States.—I do not mean to say that all sensation must definitely be interpreted either as painful or as pleasant, inasmuch as there are sensations which are neither painful nor pleasant. These are referred to as *neutral sensations.* For instance, the sight of a tree may be neither pleasant nor painful, but the recollection of certain facts associated with that particular tree may recall, at the sight of it, certain thoughts that induce a painful or rather unhappy emotion; and here it is well to differentiate emotion, which is a mental state, from pleasure-sense or from pain, which are but sensations. Ideas or thoughts may give us pleasure, but it requires an external stimulus to arouse the pleasant sensation that may accompany thought, such as is found in reading, in listening to sounds which are pleasant when grouped in the form of harmony, in hearing beautiful ideas well expressed, or in seeing wondrous productions of blended colors in the form of a beautiful landscape. Therefore, the use of the word pleasure should be restricted, I think, to the mental state following upon pleasant or agreeable sensations, which, in turn, should be called pleasure-sensations. Thus we have the emotional condition of pleasure and of its converse, displeasure.

Mental Resultants.—From every mental state, certain derivatives arise; for instance, anger is often evolved from displeasure, while pleasure gives rise to elation. It is the affective state which we are in that colors our perception and guides our acts; and it is particularly fitting, in this connection, that physicians should bear in mind that the fundamental cause of an ill-behaved, crabbed disposition very often is to be found in the elementary sensations coming from the periphery, acting as excitors to a possibly already overwrought and abnormal nervous system. How easy it is, on this hypothesis, to account for the sour and surly disposition of the dyspeptic, or the forbidding aspect of the chronic sufferer. They are worthy of our kindest consideration, for their disposition and their evil manners are often due to causes over which they have little control.

RELATION OF PAIN AND PLEASURE TO MENTAL STATES.—According to Marshall, pleasures and pains are but differential qualities of all mental states. To this I must take exception, for, to my mind, they are but interpretations of sensations which are perceived as arising in the periphery.

It would seem more fitting that pleasure, when applied to sense perception, should be spoken of as pleasure-sensation. For instance, a cool bath taken on a warm day gives rise to a pleasant sensation and at the same time produces pleasure; but thoughts of an absent one, or of some joyous past event, may give pleasure, while at the same time we have no pleasant sensation.

Next it behooves us to ask, can both pleasure-sensation and pain be perceived at the same time, and, if they are not perceived and factors which ordinarily produce them are present, is their non-perception due to the fact that they neutralize each other? It is inconceivable that two such opposites as these could exist in consciousness at the same time; and it is entirely improbable that, should such a state exist, their contra action would produce a condition of neutrality, which is the result of two active, equal and opposing forces. For instance, the distress which comes from an ulcerated stomach or an irritated sore cannot be neutralized by the physical pleasure derived from epidermic sources. We experience either pleasure or pain; there is no halfway stop where the one counteracts the other, giving rise to a state neither of pleasure nor of pain, but of neutrality. Yet, in some cases a transition from pleasure to pain-sensation may occur, for it is found that sensations which ordinarily are interpreted as pleasant may, from frequent repetition and excessive stimulation, become painful, as in pericementitis, in which at first a pleasant sensation is produced on lightly pressing the teeth together, but which, if the pressure is continued or increased, results in pain. Another example is priapism, in which the distention, which at first is pleasant, if continued, soon becomes painful. Gentle friction over the body, especially over the nape of the neck, is pleasant (to most people); yet, if the friction becomes excessive, and the nerve-endings are irritated, the pleasant sensation is transformed into a painful one. Again, a harmonious play of colors is soothing and pleasant to the eye; but let the colors be exceedingly brilliant, the pleasant sensation is transformed into a disagreeable and painful one. Another example may be deduced from the sense of hearing. We all know how pleasant to the ear are the tones of a harp; but change them into the shrill notes of the siren and we almost shriek with pain, or rather let us say distress. Yet, if now we modify the vibrations and reduce them in number, the distress disappears; and the sound, while neither painful, nor pleasant, may become pleasant if we place among its components some half tones which increase the fullness and volume. These are examples of sensations changing from pleasant to painful, and then back again from painful to pleasant. The changes which bring this about are the result of variations in the force and rapidity of the impulses impinging on the nerve terminals.

Certain laws have been deduced from this transitional interpretation of impulses from pleasure to pain, of which the two following are taken from Moher ("Psychology," p. 225), who says that:

(1) Pleasure is an accompaniment of the spontaneous and healthy activity of our faculties, and pain is either the result of their restraint or of their excessive exercise.

(2) Pleasure increases with increasing vigor in the operation, up to a certain normal medium degree of exertion, and progressively diminishes after that stage is passed. Farther on, pleasure disappears altogether, and beyond this line pain takes its place.

Whether this interpretation is correct is not yet apparent. If the receptors for light and sound, for example, have specific pain receptors, which have a definite threshold value and only react when the intensity of the stimulus has reached a definite point, then the older hypothesis that assumes that pleasure passes into pain fails. By bearing in mind the analogies in skin sensibility, it would appear that such specific receptors are probably present, and recent studies of sensation tend to show that they are present and are independent of others of a lower threshold value. Should this principle hold true for the sensory systems throughout, epicritic and protopathic, our conceptions of pain and its relation to pleasure will be markedly altered and simplified; we then may discard much of the metaphysical speculations regarding the relations of pleasure and pain. These, however, will be discussed more fully in another chapter.

CHAPTER II

THE NATURE OF PAIN

Definition.—Various definitions of pain have been given by different authors. Meade says that pain is an indication of interference with the power of nutrition of the organism; pleasure, of the elevated power of nutrition of the organism. Gilman thinks that the source of all pleasure is the renewal, on the part of the nerves, of the activity that has already become familiar to them, while pain has its source in the violation of nervous habitude. Meynert and Gilman think that the effective working of the psychic functions is the cause of pleasure, while any obstacle to these functions is the cause of pain. Sidney E. Mezes says that pleasure is attention without difficulty or obstruction, while pain is attention with difficulty. This applies to mental pleasure particularly, as close attention with deep thought is pleasant, while obstruction to this attention and thought, due to internal conflict, distress of mind, or other causes, is painful (Bianchi, p. 346). Bianchi further says that whenever there is internal emotion, or exteriorization, in response to the needs of life, there is pleasure; when the movement is hindered or obstructed, there is pain. This applies particularly to hunger pains.

The *aspect theory,* as held by C. D. Strong (473), regards pain as the highest degree of displeasure, and holds that the pain of a cut or of a burn can always be analyzed into a tactile or temperature sensation, on the one hand, and a feeling of displeasure on the other. Kulpe evidently was the inspiration for this idea, for he is quoted by Strong as saying that "the characteristic feature of pain is not the sensational quality, which is never absent, but the feeling of the disagreeable, of which pain is the highest degree." On the other hand, Lehmann does not entirely lose sight of the sensational element of pain when he says: "A feeling, whether of pleasure or of pain, never occurs apart from a sensation, however weak, and in every case where such an isolated feeling is supposed to have been observed, the sensational element has merely been overlooked."

Meyers (122, p. 744) says that pain is a beneficent reaction, through the nervous system of altered structure or disordered function, against threatening forces. Dunglison, in 1857, defined pain as "a disagreeable sensation which scarcely admits of definition"—truly a very indefinite definition. Quain (471), not more clear, said that "it is the representation in consciousness of a change produced in a nerve center by a special mode of excitation." Sudduth says that "pain is a mental state, an element of consciousness, due to the perception of an injury to the body or to the feelings." By this definition it is seen that Sudduth holds that there must be a condition of mental aptitude or perception, for otherwise it is not possible to decide as to whether or not an injury is painful.

Schopenhauer turns to scholastic philosophy and the introspective method of deduction, for he believes that "pains are positive and pleasures are negative experiences; pleasures are due to the absence of pain, and the intensity of one is often in proportion to the other feeling that preceded it" Another definition, of somewhat the same character, is given by Spinoza, who says that "pleasure is an emotion whereby the body's power of activity is increased or helped, and pain is an emotion whereby the body's power of activity is diminished or checked. Therefore, pleasure in itself is good." (Spinoza's "Improvement of the Understanding.")

As one retreats farther into the past, it will be seen that the physical properties of pain were not perceived, and that only a metaphysical interpretation was taken into consideration. The early Celts and Teutons had a mythological representation of disease, called Hela, a ghastly form who received all who died of disease into her residence, Niflheim. In this were the Hall

Elidnir (pain), her bed, Koer (disease), and the table, Hungur (Allen, 510). Cicero described pain as a disagreeable movement in the body (35); Gaubuus called it a disagreeable sensation which the mind would rather not experience; while Sauvage spoke of it as a disagreeable sensation originating from any lesion of nerve fibers (5). Valentine (507), Wundt (508) set forth the idea that too great an intensity of stimuli may cause pain; Erb held that every increase of sensory stimuli is capable of producing pain as soon as it attains a certain intensity; Eulenburg (509) states that it is a gradual increase in the feeling which accompanies every sensory process.

From the preceding, we see that there are two ideas underlying the various definitions for pain; the one physical and the other metaphysical. The older writers dwelt upon its psychological aspect, namely, that it is a disagreeable sensation, while the modern thinkers add that the disagreeable sensation is the result either of lessened nutritive activity in the cell (receptive or perceptive), or is the indicator of the reaction against whatever tends toward the destruction of the organism.

Universality of Pain.—As an evidence of the universality of pain, we find words expressing it in all languages; and as an evidence of the antiquity of its existence, we find that the word expressing it is practically the same in all languages having a common origin. In the English language, the name is probably derived from the Middle English, and is a term used to convey the idea of suffering. This, in turn, like a similar expression found in all modern languages, was probably derived from the Latin *pœna*, which means a punishment, and which no doubt originated in the Greek word ποῖνα, also meaning a punishment or penalty.

Metaphysical Consideration of Pain.—Thus far we have been considering pain as a sensation. This, according to Marshall ("Pleasure and Pain," p. 25), is untenable, for the following reasons:

A sensation must have a receptive, a conducting, and a perceptive organ and

(1) No center for pain has ever been defined or located.[1]

(2) No special means for pain production are present, as in the case with other sensations.

(3) Pain is aroused by the most varied stimuli, while sensations are aroused by well-defined and limited stimuli, which must be exerted upon a special sensory-perceptive apparatus.

(4) Sensations are themselves both painful and pleasant; therefore, pain and pleasure are but attributes of sensation, and cannot exist by themselves as separate sensations. For instance, heat, cold, taste, smell, hearing, and sight may all be painfully, as well as pleasurably, perceived.

(5) Pain may exist in the intellect without any peripheral cause, but in this case it generally acts as a qualifying factor in emotion, which is a mental state. It is extremely difficult to say whether an abstract idea can or cannot be painful. Perhaps the most we can say is that it is either agreeable or disagreeable.

(6) Another argument sometimes advanced against pain being a distinct sensation is that we can draw up in the imagination a representation of sensation without its actual presence; but we cannot, by any stretch of the imagination, conjure a picture of a pain, but must always associate it with some sensation, such as touch, heat, cold, etc.

Newer research has shown that Marshall's position is absolutely untenable, but we shall for a moment discuss its merits and demerits, with the hope of adding light to the whole subject. With regard to Marshall's first proposition, that no center for pain has ever been defined or located, it may be said that while, as a rule, physiologists and psychologists do not limit pain perception to a particular region of the brain, they hold a rather unanimous belief that the sensations, of which pain constitutes a part, have their centers in the postcentral gyri. Calkins speaks more definitely. He holds that the centers for pleasure and pain are in the frontal lobes, and that it depends upon the state of nutrition of these cells whether the excitation which comes from the motor areas of the Rolandic fissure produces pleasure or pain. If the cells are in a building-up process, that is, in the stage of anabolism, the result is pleasure; if they are fatigued, the result is pain. If the state of nutrition exactly corresponds to the state of need, the result will be neither pleasant nor painful, but will be one of indifference. This is a purely speculative hypothesis. What, in the first place, produces the nutritive derangement in the frontal lobes? It is a fact that a patient who is fatigued, either mentally or physically, will feel painful stimuli more acutely than one who is not in such a state of fatigue; but it is also true that fatigue is not necessary to the perception of pain, since even those who are in the best of health may suffer from it.

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[1] At the present time, however, most physiologists hold that the pain center is located in the optic thalamus.

More recently it has been held that the pain perceptive centers lie in the cortex of the postcentral convolutions, but Thomas and Cushing (512) found, during an operation, that the postcentral convolutions could be manipulated without pain, the patient at this time being perfectly sensible and alert to all sensory phenomena. The operation consisted of incision of the cerebral cortex and removal of a tumor, all without pain. During the operation, the patient had not the "least sensation of any description, though the operative technic required the cutting across and the breaking up of many fibers, as well as the irritation of the gray matter." It is interesting to observe that these areas credited by many with pain production were, when irritated, entirely insensitive. This, however, may not entirely negate their presence because painful stimuli are effective only in the receptor end of the neuron or in the course of the neuron, and it is likely that the center of perception, since it possesses no adequate apparatus to receive a pain stimulus, would be unable to perceive it. Centrally projected pains, as from thalamic lesions, are of another type. Here the associative memory centers lie and at the same time it is the region where the third neuron of the sensory nerves arises—and thence passes to the periphery. However, if centers for pain perceptions are admitted, there must be more than one; and at least two must be separated: (a) centers where the sensations are received, and from whence they are projected to the perceptive centers, as the thalamus, for instance (*see* thalamic lesions), and (b) centers which record the painful impressions in memory, and in the future, either upon some subjective or peripheral irritation, project them into the perceptive centers, where they give rise, in consciousness, to the sensation called pain. The following diagram exemplifies the meaning of this:

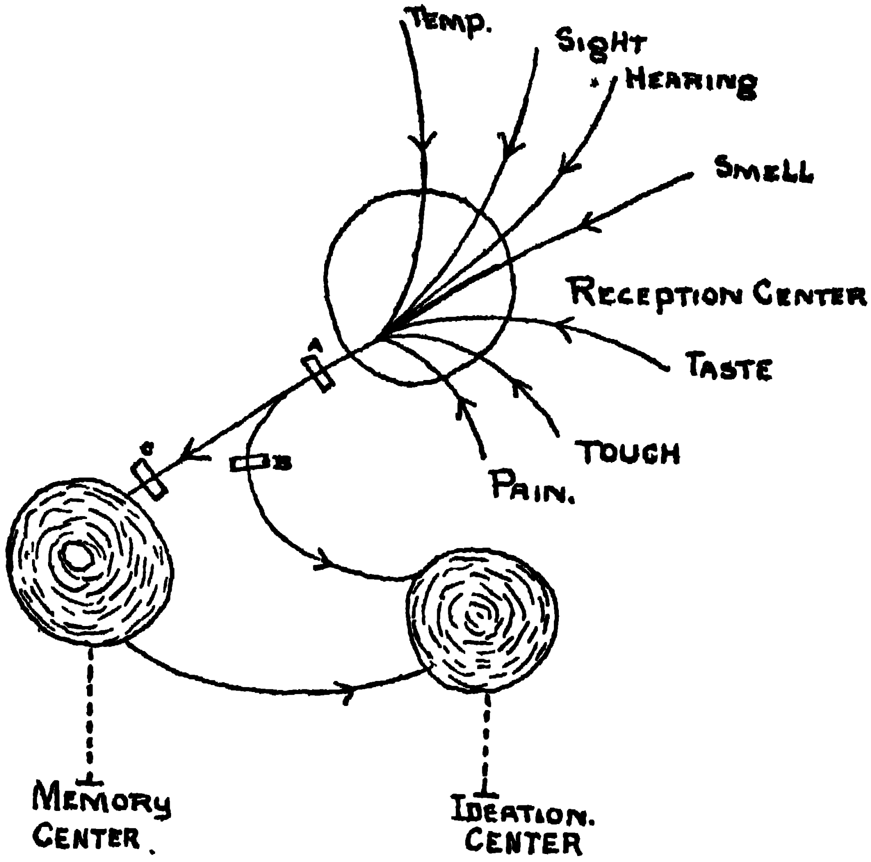

FIG. 3.—SCHEMATIC ILLUSTRATION, SHOWING HOW THE VARIOUS SENSATIONS ARE TRANSMITTED FROM THE PERIPHERY TO THE BRAIN CORTEX AND FROM THENCE TO THE TWO BRAIN CENTERS.

(1) The *ideation* center where the different perceptions are correlated into thoughts and ideas (objective sensation), and (2) the *memory* center, where the separate perceptions are stored until again they are called into consciousness. A block at A would occlude all sensory perception of stimuli and the memory storage of the same. A block at B would occlude the transmission of present acting sensory stimuli, so that they would not be perceived in consciousness. However, the center still receives impulses from the memory center, which it may evolve into consciousness, where they are perceived as acting in the present (subjective sensation). If the path to the memory center is destroyed, all recollections of prior sensations are lost, and the ideation center, owing to lack of comparison with previous sensations, would be unable to correctly interpret the ones it then receives and may interpret cold as heat, or touch as pain, etc. (paresthesia).

Memory Centers for Pain.—It is further evident that all of the energy received in the areas for painful impressions is not transferred to the areas of perception of pain, but that some of it is transmitted to the memory areas, from whence, in the future, it may be transferred to the areas of mental perception of pain, thus giving rise to pain which is subjective in consciousness, and therefore called *subjective pain.*

In regard to Marshall's second point, it will be shown later that special fibers for pain conduction do exist in the peripheral nerves, cord, and brain (cortex), and that these fibers carry impulses from pain receptors existing in special areas, and have the single function of carrying pain impulses and no others. Head has done more than any other observer to establish the fact that the different sensations have separate receptive organs, which receive stimuli peculiar to them and to no others.

Marshall's third objection is harder to meet, in the present state of knowledge, for it may be true that certain irritations, exerted to excess on some sense organs, may produce pain. While as yet no specific pain fibers have been discovered to be present in the retina of the eye,[1] it is not improbable that such fibers exist; or, should they not exist, that the reaction which excess of stimulus produces in the receptive optic cells in the brain causes fatigue of those cells and that this is transmitted to the fibers of adjacent cells, in which a reaction interpreted as painful is produced. That such a hypothesis is not entirely without basis, may be seen from the assertion that "there are special pain nerves running parallel to and in the same trunk with the sensory nerves, having a special sense of perception in the brain, and operating only under the influence of intense irritation." Matzinger's (328, p. 138) statement, that "it is unlikely, and contrary to natural laws, that there should be an elaborate mechanism of highly organized tissue which is destined never to come into use in some individuals, or at least only in a very limited way," will have to undergo modification, for it has been proven that there are such tissues in the form of special nerves (pain, etc.) for certain types of sensation (Edinger, Head, Strumpell, etc.).

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[1] In this respect, Foster ("Physiology," 5th edn., Part IV, pp. 281, 282) agrees with Goldscheider (473, "Ueber den Schmerz," p. 8), and in speaking of the pain from stimulation of the retina, says: "We have no evidence that simple stimulation of the retina, however excessive, will give rise to pain, meaning, by pain, the kind of sensation we feel when the skin is cut or burnt. We have no evidence that an auditory, or an olfactory, or a gustatory sensation can, through mere intensity, become converted into a sensation of pain. We may assume that the pain which we feel when the finger is cut is a wholly different thing from the pain which is given to the most delicately musical ear by even the most horrible discord." These considerations suggest to Foster that cutaneous pain is not simply an exaggeration of tactile and temperature sensations, but a separate sensation developed in a different way.

As to the fourth objection, that pain must be an attribute of sensation because each sensation may be both painful and pleasant, it is rather difficult to formulate a proper answer. Were it not for its clear separation, in the skin, from all other sensations, one would be forced almost naturally to the conclusion that pain really is only a qualifying factor in sensation. Yet it is possible that the pain sense which one finds in the periphery is a highly differentiated touch-sense; that pain is present in other organs from a too great stimulation of their sensory end organs; and that pain is present in their centers from overactivity.

The fifth and sixth arguments are not supported, in view of the general hypothesis that there are specific pain sensations.

Causative Factors in the Production of Pain.—The production of pain depends upon the presence of a proper stimulus and the integrity of the receptive, the conveying, and the interpreting apparatus. The stimuli may be divided into those due to mechanical changes in pressure, to toxemia, to chemical changes, and to electric or thermic reactions. The stimuli due to *mechanical* changes are exerted either upon the terminal filaments of the nerve, or on some of the neurons extending from the brain to the periphery. This mechanical irritation may be due to *pressure from an inflammatory exudate* (see Inflammatory Pain), to *pressure by new growths*, or to *prolonged, strong contraction of a hollow organ* (Mackenzie). *Hemorrhage* in the body tissues will almost invariably cause either deep pressure pain, or epicritic pain

(Head), unless the rupture is an areolar tissue, when, owing to the looseness of the tissues, pain is not present until the local distention becomes excessive, or until pressure is made on adjacent structures. In regions where the tissues are denser and more compact, pain is very severe, even from the beginning of the hemorrhage, as in hemorrhagic pancreatitis. In cavities, also, hemorrhage is often provocative of the most intense distress. This is particularly true of the peritoneal cavity. The cause of this excessive pain is rather hard to determine, in view of the fact that in this location the resistance to the hemorrhage is almost negative. It may be that blood possesses some substances which are particularly irritating to the peritoneum, and that this irritation is transmitted to the body wall as pain. Even as hemorrhage causes pain, so also in some cases of congestion, it eases the pain, as in swollen turbinates, premenstrual congestion of the uterus, etc.

The *extent of the surface stimulated* is important in the production of certain kinds of pain. If the area of stimulated surface is too small, no pain is felt. It seems that, in certain areas, only an aggregate of stimuli can produce pain (Tigerstedt, 483, p. 467).

The stimulus which causes pain may not be of any greater magnitude than that which is daily experienced by the organism; yet, from frequent repetition, a condition is reached in which, before recovery from one stimulus, the cell receives another, and so on. Each stimulus leaves a little of its irritative quality, until the tension from the accumulation of these irritative remnants becomes too great, and release of nervous energy takes place in the cell, the pain threshold is reached and the sensation of pain results. After once having overcome the threshold, secondary discharges take place on a slighter provocation.

Sudden alterations of blood pressure create pain, as is seen when a tourniquet, which has been on a limb for several hours, is removed.

Toxemia is a cause of pain, particularly in severe anemia of a part, such as is found in emboli of the arteries.[1] James reported a case of complete obstruction in circulation of the aorta, in which, after the ligation, the patient had the most severe pain (D. W. Mitchell, 263, p. 52). The causes of this, "Brown-Séquard thought to be an accumulation of CO_2 in the tissues. Vulpian regarded it as being due to the lack of oxygen, while W. Mitchell thought that it might be due to sudden annihilation of nutrition, osmosis and conditions of pressure."

Pain may also be due to the *accumulation of toxic products*

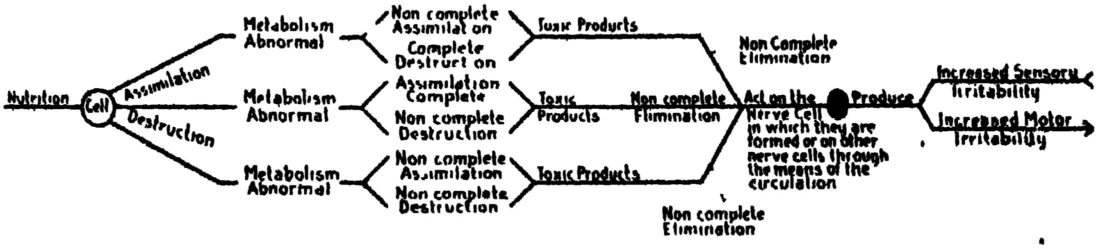

Fig. 4.—Diagram showing How Changes in the Cell Metabolism May Produce Changes in the Irritability of the Cell and a Departure in its Reaction to External Stimuli, Either Making it More or Less Sensitive to Peripheral Irritation.

in a part, as exemplified in the fatigue pains of muscle, wherein the products are the result of metabolic waste; or else the toxin may be derived from exogenous sources, as from the alimentary tract or from an outside toxic agent, alcohol, etc. It may also be the result of toxins from bacterial organisms. The toxin acts upon the receptor cells, or on the sensory nerve substance to which the irritant may be transferred.

As to *chemical* causative factors, there may be many, principally in burns, severe ischemias, etc. From the nature of the condition, toxemias might also be classed among chemical agents, inasmuch as in toxemia the poison or irritant is of a chemical nature.

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[1] Very severe pain is felt in infarct kidney (Halperin). Pain is also extremely severe in arteriosclerotic thrombosis (Buerger and Geis). Intense pain is also felt in arteriosclerotic thrombosis of the lower limb, a disease which is especially prevalent among the Russian Jews. The pain is so agonizing and constant that the poor sufferers will consent even to the extreme remedial measure of amputation rather than bear longer suffering.

Decreased alkalinity of the blood, as suggested by Sir Lauder Brunton,[1] may also produce pain. This may explain the cause of the generalized aching pain that is present in infectious diseases.

Photochemical changes in the rods and cones of the retina of the eye are produced by light. When the light is too severe, these changes are excessive, and the stimulation of the optic nerve is stopped or modified, so that vision is obscured and pain results (Matzinger, 328, p. 139).

In some cases trophic changes in the skin may also produce pain. This may be peripheral, due to irritation of the sensory receptors (protopathic), or central, due to changes in the sensory cell distribution in the cord.

Electrical reactions cause pain, as may be proven by the use of the painful, interrupted electrical current (Head, 519). This is one way of testing sensitiveness to pain (see Intensity of Pain).

Heat and cold are frequent causes of pain production, the reason evidently being some chemical change in the region of the sensory receptors. This, however, will be more fully considered in the section devoted to the relation of pain to temperature. Freezing of a nerve will cause such an irritability of the nerve, below the point frozen, that the least pressure upon it causes pain in its distributive area (Weir Mitchell, 263, p. 18).

Apparatus for Receiving and Conducting Pain.—The various forms of *receptive apparatus* are not, as yet, well defined. Special terminal filaments are present for certain forms of stimuli, but their distribution is little known. From the universal presence of pain, it would seem that the sense-receptive organs for pain are widely diffused. These receptors are capable of receiving pain stimuli of various kinds, touch, deep pressure, heat, cold. Their action may be abrogated by excessive cold, cocain, vibration, electricity, etc. These terminal filaments in the skin have been called noci-ceptors (nocuous ceptors) by Sherrington (522). He classifies as receptors all organs in the skin and mucous membranes which have developed by a long series of evolutionary changes, and which have the ability to distinguish stimuli arising from different sources, such as temperature, pressure, or touch. Those portions of the body most subject to injury should, therefore, have a more numerous supply of noci-ceptors than those portions which are not so exposed. If this is true, we should find the fingers, which are exposed to injury, better supplied with these ceptors than the brain, which, because of its inclosure in the skull, is prevented from injury. Such is the case; for in the brain, the cortex is found to be relatively insensitive to many stimuli which ordinarily cause pain sensations (Crile and Sherrington).

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[1] Sir Lauder Brunton (516) states that he became infected with the staphylococcus pyogenes aureus, and that numerous boils developed which had a stinging, burning pain, generally worse about three or four hours after eating—a time when digestion would be most active, the absorption of the acid-formed contents of the stomach greatest, and the alkalinity of the blood, from their absorption, least. From this he concluded that the pain was due to a decreased alkalinity; and, proceeding on this assumption, he took fairly large doses of alkalies, with a resulting diminution of pain. He then tried the effect of the bicarbonates, applied directly to the boils, with a consequent diminution of pain. In toothache, also, the application of bicarbonate of soda to the cavity of the tooth has a beneficial effect.

The *pain-conducting apparatus* consists of the nerve fibers leading from the periphery to the sense-perceptive centers. Any irritation to the axis cylinders of the sensory nerves in this pathway will be transmitted to the periphery and be felt as *pain*. Irritation may be in the form of inflammation of the nerve (neuritis). of the ganglion (herpes), of the post roots (tabes) within the cord (transverse myelitis), or in the thalamus. Various agents may act upon the axis cylinder processes (nerves), such as tetanus toxins, arsenic, alcohol, etc. The headaches of toxic origin, familiar to all, are usually due to stimuli, acting upon the dural distribution of the trigeminus.

Pressure on the conducting fibers causes, as a rule, a severe pain reaction. Yet, it is possible for pressure, when equal and constant, to be very severe without producing any pain reaction. It seems most potent for pain production when it varies in intensity; the more variable the pressure the greater the severity of the pain. Such a pressure we see exerted by new growths, as tumors or cysts, or by inflammatory changes, as in meningitis.

The *sense-perceptive centers in the brain* may, from oft-repeated stimulation, become hypersensitive. It is often the case that, after the original cause has ceased, the hypersensibility remains, so that stimuli of ordinary intensity, when they reach these centers, may be interpreted as painful. Whether this is due to a hyperactivity of cortical cells, or to a lowering of the threshold values in the receptors, has not as yet been definitely established. The so-called occupation neurosis, in which pain is present when the patient attempts to perform some accustomed task of manual dexterity, may serve as an example of this. Here the pain, as well as the spasm which accompanies it, may be said to represent a rebellion on the part of the overused cortical centers. This rebellion does not seem to be so much upon the part of isolated centers as due to fatigue in the association of certain stimuli, which are carried to the affected area from other centers, and which have the power of producing certain coordinate actions. The same centers may be called into play to make other movements of the same muscles without producing pain. Thus, a person who is unable to write without pain may be able to sew without any trouble (Walton, 517, p. 261). It should not be overlooked, however, that such acts are only *apparently* similar. In reality they are quite diverse.

We have spoken of the lowering of the threshold to pain. In neurasthenia it would appear that, for reasons as yet unknown, such a reduction takes place so that the body is more capable of reacting to stimuli (including pain) than when it is in a normal state.

Shock, anxiety, apprehension, have an effect in lowering the pain thresholds for various stimuli. Just what the molecular factors may be underlying this change no one knows. Clouston's phrase, "disturbance of molecular equilibrium," is as good as any other, whatever it may mean.

Pain and Mental States.—*Emotions,* like anger and fear, sometimes give rise to severe nervous attacks which are typified by headaches; and in this relation it is an odd coincidence that only the unpleasant emotions give rise to disagreeable sensations, for surely no one has ever heard of a pain (headache) being produced by joy or happiness. *Hypnosis* may also have the power of bringing into the patient's consciousness an intense perception of pain. Some blindfolded persons will experience what they think to be pain, if, prior to running a cold instrument across the skin, they are told they were going to be cut. In the dream state, also, vivid sensations of pain may occur. One of my patients, a non-pregnant woman, has been aroused frequently by apparent labor pains, of which she had not the slightest perception upon awaking. The *modus operandi* of this perception was described when, in speaking of consciousness, the method of transference of impulses from the receptive center to the perceptive center was illustrated. There has been some controversy as to whether it is possible to *imagine* pain. The answer seems to be simple; for how else would it be possible for the hysteric to draw from memory's store, and present to vivid view, sensations which are as realistic as though they were actually taking place? And is not imagination, of which the hysteric unconsciously makes abundant use, but the power of transferring sensation from the warehouse of past experiences to the mart of present change?

Relation of Pain to Other Sensations.—We now approach the most difficult part of our subject, namely the consideration of pain in its relationship to other sensations. Pain is so inextricably mixed up with other sensations that at first it would seem almost impossible to unravel the skein. Yet, the riddle is not so difficult to solve if we only recognize one factor, and always consider it in our study of this subject. This factor is *evolution.* If we reflect that our nervous system is the development of nameless thousands of ages; that from a most simple form it has developed to a most complex system; and that during this development its structures and functions have constantly been modified by and adjusted to the changes in environment, it is easy to understand how, by these constant changes and innumerable modifications, it has reached its present complex and intricate form. The nervous system at first (in our progenitors) was very crude, being little more than that which was essential for the carrying on of the two great functions of the organism, namely, growth and reproduction. As the organism developed, it became more and more susceptible to external influences, and more and more cognizant of its environment and the physical state of its being. At the same time, the means of defense were improving, so that the organism was better able to protect itself from injury and the external dangers of which it was just becoming aware. Probably it was at this time that the various external senses were called into activity. An analogue of this is seen in the human embryo, in which it is held (Mackenzie, 69) that the cerebrospinal system is a later development than the sympathetic, the sympathetic being concerned with the essential processes of life, while the cerebrospinal is concerned only in communicating to consciousness the relationship to surrounding objects, the relationship of different portions of the body to each other, and the intensity and variety of stimuli which are received from different sources. In other words, cognition is dependent upon this exterior system. So, it is held that the development of the cerebrospinal system is for the purpose of defense against injury, and that the principal means of communicating the existence of such an injury to consciousness is by a series of disagreeable stimulations which, by long association, have been grouped into various groups and are called *pain.*

Yet, pain to touch is not the only sensation which, because of ancestral necessities, has been developed from the primal sensibilities of a simple organization. In the same class are temperature, light touch, and deep sensibility. Light touch, as it was probably the last to develop, is the most vulnerable; so that, in lesions of the peripheral nerves it generally is found to be one of the first sensations to disappear. Touch and pain have been regarded by some as variations of the same sensation. From the following facts, however, these two sensations cannot be considered the same:

(1) The distribution areas of touch and pain are not identical. Were they but modifications of the same sensation, their localizations would be exactly similar, and both would be present at the same time. The exact opposite of this was present in a case reported by Head and Thompson (206, p. 553), where, in a

lesion of the spinal cord, an area on the limb was insensitive to pain, while it was sensitive to light touch and pressure.[1]

(2) Another illustration in point is given by Biernacki (Witmer, 527), who states that pain and temperature sense can be made to disappear by pressure on the ulnar nerve, while the other sensations, as touch, localization, and muscular sense, remain. This would argue either for special nerves of pain, or else for the reduction in the conductivity of individual fibers; so that if pain, in the case of touch, is due to increased molecular vibration, the fibers would not be able to carry the stimulus. Yet, such a supposition is hardly tenable, from the fact that disease of the cord, and of a certain area of it, will produce a loss of pain conduction, but not of light touch; and, *vice versa*, lesions in the cord may produce a disturbance of light touch perception and not of pain perception.

In a case reported by Gowers a unilateral hemorrhage into the lateral columns and gray substance of the upper cervical cord produced analgesia and thermoanesthesia. In this case there was a complete loss of pain on the opposite side of the body, without disturbance of light touch

From the above it would seem that the pain and temperature senses are more closely related than are pain and touch. In other conditions the senses of touch and pain appear intimately related, as is shown, when by gradually increasing the pressure on a part, the sensation produced changes from that of touch to actual pain. Witmer found that a maximal pressure of 1.0 gm. or 2.0 gm. will give the sensation of touch greater intensity. The same stimulus, ranging from 20.0 gm. to 15.0 kgm., produces a sensation of pressure, while at times a pressure of 5.0 kgm. to 15.0 kgm. will give rise both to pressure and pain sensations. A maximal stimulus above 15.0 kgm. gives rise to pain only. This Head has shown is due to specific receptors of deep sensibility whose threshold values are approximately stated by Witmer.

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[1] This is frequently found in *dissociation paralysis*, which is conspicuously present in syringomyelia. It is also found, less marked, but much more frequently than is usually assumed, in neurotic processes, in tabes and in paralysis, as well as in alcoholic and hysterical persons. (Osler's "Modern Clinical Medicine," "Diseases of the Nervous System," p. 194).

In tabetics, also, it is very common for some dissociation between pain and touch to be present, as frequently the patient will feel the touch of a pin point much sooner (one or two seconds) than the pain caused by its penetration into the skin. The term *delayed pain sensation* is given to this state.

A dissociation between pain and touch sensations may also be present under the action of cocain, chloroform, tabes dorsalis, hysteria, hypnotism, etc. During operations, when anesthesia is not complete, it is rather common for the patient to complain that he feels the touch of the knife, but no pain. Should pain be present and touch be absent, the patient will be unable to localize the pain; and, inversely, it is found that the more acute the tactile sense of a part is, the more accurate is the localization of pain in that part (Hall, p. 142).

Of the sensations, pain and temperature seem to be the ones most closely connected at least, this holds true in regard to the cord, for lesions here more frequently produce a dissociation between the other sensations than between pain and protopathic temperature. That they represent degrees of the same sensation cannot be held, because, in the first place, the temperature sensation may remain when all the others are absent (Head and Rivers, Ref. 86). In such cases, the patient does not respond to painful tactile stimuli, but to painful heat or cold stimuli. This would apparently show a difference either in the origin of or in the conduction of these two sets of stimuli. Yet, pain can be produced by a temperature of 36.3° C. to 52.6° C., and cold pain by a temperature of + 2.8° C. to — 11.4° C. (Dana, 529), when the tactile sensibility and the cutaneous pain sensation are lost.[1] This differentiation of sensation can occur only when the superficial nerve is diseased, and deep sensibility remains; for the part of the nerve conveying deep sensibility runs with the muscular branch of the superficial nerves, and so may escape injury in case of destruction of the cutaneous sensory branch. The sensibility to temperature changes is not equally distributed, it being greater in some places than in others. That heat and cold sensations have separate receptors can be deduced from the fact that one may be present in the absence of the other. Rivers and Head (86) report a case where the sensation to cold was independent of any other sensation. It has been known for some time that heat and cold sensations have special areas on the skin where they alone, of all the sensations, are present (Goldscheider). Thus it will be seen that, in the course of development, certain nerve elements, becoming more highly specialized, have arrogated to themselves special functions, one of which is the power of being stimulated by hot and cold objects. These receptors, devised for temperature, are insensitive to electrical and mechanical stimuli (Rivers and Head, 86, p. 385). It has also been found that stimulation of temperature points or spots by a needle will not produce pain (Tigerstedt, 483). Excessive stimulation by heat or cold may produce only the sensation of pain. While it is probable that the correlated senses are present, they are not felt because of the overwhelming of the consciousness by the intensity of pain sensation. Hyperalgesia to temperature may be present without hyperalgesia to touch (Stern, "Archiv fur Psychiatrie," 1886); and it has also been noted that hyperalgesia for heat may not be as marked as it is for cold.

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[1] According to Weber, "the pain produced by heat and cold is very different from the sensation of heat or that of cold. If the pain is not extreme we feel at the same time the heat or cold which causes it, and can then distinguish pain due to heat from pain due to cold. But if it is extreme, the sensation is the same, whether caused by heat or cold" (Strong, 473). The pain sensation is located deeper in the skin than the terminal filaments which transmit cold, because, "on contact of a cylinder, slightly heated, with the

Conveying Channels for Sensations.—It is apparent that while

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skin, on which a blister had been applied and the epidermis removed, a painful stimulus without a trace of heat sensation was felt'' (Mettler, 505).

A case in point is reported by Barker, wherein, because of pressure of a cervical rib, certain conditions occurred in the area of distribution of the nervi cutanei brachii et antebrachii mediales of the left arm. He found that in some areas careful testing showed that pricks with a fine needle gave only pain, without calling forth previous touch or pressure symptoms. Ice at first gave no sensation, then pain Heat gave rise only to heat pain, without previous heat sensation. A stimulus of 47° C. (116.6° F.) and upward quickly caused pain, but no sensation of warmth. Barker claims that the pain was due to stimulation of pain organs (Witmer, 527) the sensations of touch, temperature, pain, and deep pressure pain are closely related, they are separate entities, and that each is carried by its own specially differentiated and functionating nerves.[1] We have already referred to these, but will discuss them again more at length.

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[1] There has always been considerable discussion among physiologists as to the presence of pain nerves and pain tracts. Advocating the existence of pain nerves are Strong (533), Krehl (534), Von Frey, Piersol (537), Nichols, Bianchi ("Psychiatry," p. 358), Funke, Head, Goldscheider, etc. Opposing the idea are Hall, Marshall, Mantegazza (536), Dana, Brown-Séquard, Munsterberg, James, Ziehen and Weir Mitchell (263, p. 40), who says:

"Do you suppose that there always exist in these organs pain nerves, and that only once, perhaps, in a lifetime, these filaments are to be roused into activity?" He further says: "As regards the skin, how shall we deal with the like difficulty if we choose to believe that everywhere are peculiar nerve fibers devoted only to transmitting painful sensations?" So he concludes that pain is not a "distinct sense, with afferent tracks peculiar to itself," but that it is "the central expression of a certain grade of irritation in any centripetal nerve." He goes on to say (p. 48) that if a nerve is cut, and "the nerve ends, having been allowed to cicatrize without union, should be constantly irritated by imprisonment in the hard tissue of stumps or scars, or by a neuritis, a great variety of peculiar sensations are felt, such as the feeling of being tickled, of motion in the lost or disconnected part, heat, cold, etc. These facts seem to prove that some peculiar peripheral arrangement for the production of touch, sense of movement, and the like, is without firm physiological foundation."

The last example is hardly to the point; yet, at the time of writing, it was well taken. To-day it is recognized that, upon irritation of a nerve, the pain is referred to the peripheral distribution of that nerve because the brain cells have learned to interpret such a stimulus as coming from a particular area, and will so continue to interpret it when the direct communication with that area is interrupted; so that irritation applied in the course of a nerve is always felt as though it were coming from the peripheral distribution.

One of the strongest advocates of special nerves of pain is von Frey, who gives the following reasons for his belief:

(1) "By observing certain precautions, mechanical stimulation of the skin with a bristle produces a pure sensation of pain, without any preliminary or accompanying sensation of pressure.

(2) "If a bristle be placed over a pressure point, the sensation appears immediately, but at once fades away again, and usually becomes unnoticeable after a short time. Over the pain point, the effect appears later, gradually increases in strength, and decreases again after reaching a maximum.

(3) "When the head of a pin is pressed for a moment into the skin there follows very often, after the sensation of pressure, and separated from it by an appreciable interval, the sensation of pain."

Von Frey claims that on the back of the hand, over the metacarpus of the ring finger, sixteen pain points can be demonstrated as against two pressure points. The nerve endings which convey pain are, he believes, probably the free intraepithelia nerve endings (Tigerstedt's "Physiology," p. 467);

The channels for conveying sensibility are divided into superficial and deep sets (Head and Thompson, 206). The superficial set is again divided into two others, the *protopathic*[1] and the *epicritic.* These differ from each other principally in their power of conveying degrees of stimuli, the epicritic being finer, and capable of conveying slighter degrees of stimuli. It is probably a later evolutionary development than the other. Pitt (530) states that it is developed after birth. According to Head, Rivers, and Sherren (85), Head and Sherren (86), and Head and Thompson (206), the systems for conveying sensations, with the stimuli which they carry, are as follows:

I System of Deep Sensibility	II System of Protopathic Sensibility	III System of Epicritic Sensibility
Deep pressure, which, when excessive, is interpreted as pain. Localization of pressure. Alterations in the positions of the joints, muscles and tendons.	Painful cutaneous stimulations. Extremes of heat and cold (below 20° C. and above 45° C.). Visceral sensation. Painful sensation from a prick. Electrical stimulation.	Light touch. Character of touch. Number of points of pressure. Distance points are apart. Character of surface touched. Slight differences in temperature.

Wündt (Strong, 437) assumes that in the peripheral nerves the paths of pain impulses are the same as those of touch, heat and cold impulses. When tactile or temperature impulses reach the cord they find two paths open: a primary path, leading through the white matter, and a secondary path, or paths, leading through the gray matter. Impulses of moderate intensity take the primary path, and this path can accommodate only moderate impulses. When excessive impulses come, they overflow into the secondary paths and pass upward through the gray matter. Funke and Goldscheider ("Über den Schmerz," p. 19) agree with the assumption that each nerve carries two sets of impulses, one giving rise to the ordinary correlated sensations, and the other producing pain.

The very full discussions of Head and Holmes (*Lancet,* January, 1912) give the latest summary of these studies.

[1] Goldscheider (62b) holds that the protopathic system does not exist, and that the so-called protopathic sensibility is but an expression of the lessened functional power of the nerve apparatus.

According to Head and Rivers, the fibers conveying deep sensibility accompany the muscular branches of the nerves, and are distributed, in many cases, to the deeper tissues and the tendons of the muscles. This is in accordance with the anatomical findings of Sherrington (205, pp. 255-256), who says that "macroscopic nerve trunks are not purely motor, but are sensorimotor or purely sensory. Such nerves as the phrenic, hypoglossal, recurrent laryngeal, and posterior interosseous contain an abundance of fibers from sensory ganglia." In muscles, the special end organ for root ganglia fibers is called a muscle spindle (Kuhne).

The nerve fibers conveying these different sensibilities do not all converge into the same nerve or roots, although the fibers conveying the same sensation from the same part of the skin do so, as a rule. For instance, the protopathic fibers from the same area converge and are all found in the same posterior roots. As a consequence, in root injury (diagnostic point for root injury) they do not overlap, while the epicritic fibers do, being conveyed, probably, by several roots and first being merged in the cord.

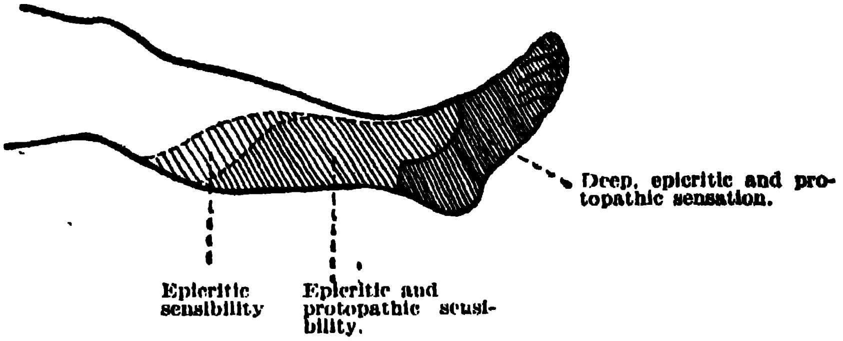
Deep, epicritic and protopathic sensation.
Epicritic sensibility
Epicritic and protopathic sensibility.

FIG. 5.—AREAS OF EPICRITIC AND PROTOPATHIC SENSIBILITY.

In the accompanying drawing is seen the effect of injury of the sacral plexus below the point where it is joined by the second sacral nerve. The third sacral nerve had been destroyed, and the nerves were bound up in a dense mass of fibrous tissue (Head and Thompson, p. 552). This illustrates the effect of injury to the peripheral nervous system before the fibers have been joined into separate conduction paths in the cord. These conduction paths for pain, muscle sensibility, touch, and pressure are separate and distinct. This is illustrated in Fig. 6, taken from Head and

Thompson, which shows the effect of injury tion paths in the cord.

The painful impulses from the skin enter t the protopathic system. They probably become

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Dogiel and Onuf
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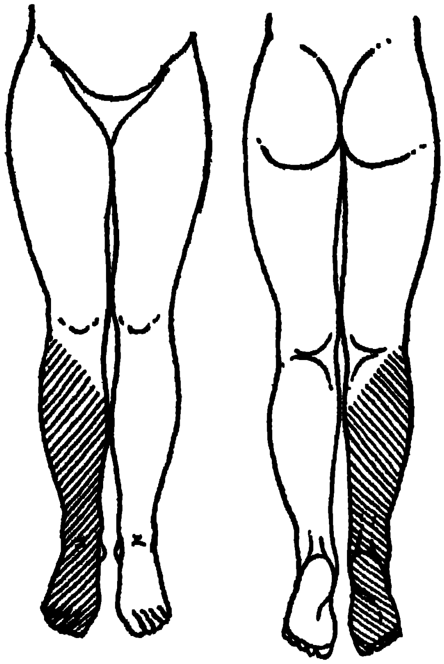


Fig 6 —Effect of Injury to the Pain-conduction Paths in the Cord.

In the shaded area the parts were insensitive to all painful stimuli, while at the same time they were sensitive to light touch and pressure (From Head and Thompson, 206)

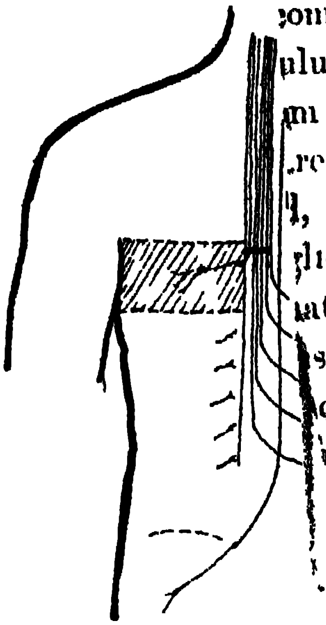


Fig 7 Unilateral Complet on One Side of the Cord ing a Narrow Band of Anes on the Same Side at the Lev the Lesion and a Broader Zo Anesthesia on the Opposite Slightly Below the Level of the Lesion (From Edinger, Nervösen Zentralorgane,6 Auflage, p. 377, Fig 263.)

and enter the intramedullary system at the level of their entrance. The fibers from the deep system do not enter by the same posterior roots as those conveying painful cutaneous stimuli. Thus, more than one segment of the cord is required before all the painful impulses from any one part of the body can be gathered together and recombined. After being recombined, they pass across the commissure to the opposite side, where they ascend in the tractus spinothalamicus et tectalis. The decussation takes place in the course of four or five spinal segments (Piltz, 407). According to Camp, it may take six to eight. This peculiarity of structure accounts for the irregular distribution of pain sensation in unilateral lesions of the spinal cord. If the lesion is not extensive enough to involve all the fibers coming from a part, there may be a very indefinite loss of sensation; but if the lesion is extensive, there is a definite loss of sensation in an area above and an indefinite loss below the lesion, while on the opposite side of the body the sensations are entirely abolished below the level of the lesion. Fig. 7, from Edinger, shows nicely the sensory results following a unilateral lesion of the cord.

In the accompanying drawing an effort is made to illustrate the course of the sensory fibers. The fibers for all the sensations enter the posterior root separately, and pass from thence to the cord. In the ganglion, these fibers come into relationship with the ganglion cells, with which they are connected, some of the

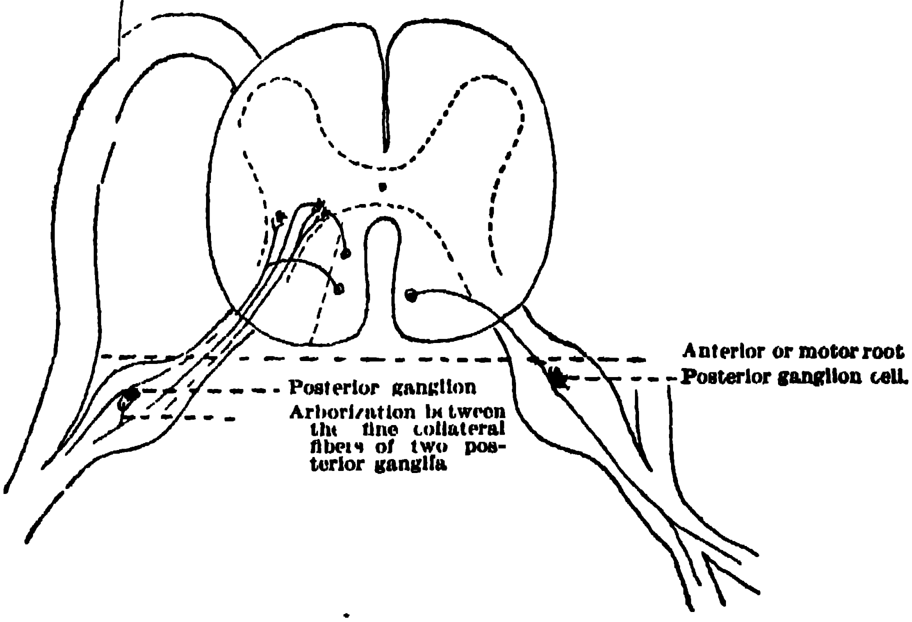

Anterior or motor root
Posterior ganglion cell.
Posterior ganglion
Arborization between the fine collateral fibers of two posterior ganglia

FIG. 8.- CROSS SECTION OF THE SPINAL CORD.
This represents on the left side the views of Dogiel and Snuf on the course of the sensory fibers in the posterior root; while on the right side is illustrated the view of Donaldson in regard to the division of the sensory neuron.

ganglion cells being connected with more than one afferent fiber (Head and Thompson, 306). It is in these ganglion cells that the afferent fibers from the viscera have their origin. According to Warrington and Griffith (414), not more than two per cent. of all the cells in the spinal ganglion are connected with the viscera. This accords with Langley's statement that the total number of sensory fibers distributed to the viscera about equals the number of sensory fibers present in a posterior root. Dogiel and Onuf found the axis-cylinder processes of certain cells of sympathetic ganglia terminating around cells of a spinal type.

Ludlum suggests that the visceral nerves may give off collaterals in the spinal ganglia, and that these, coming in contact with a spinal neuron, may transmit the stimulus to it. This stimulus would then be perceived as coming from the peripheral distribution of the neuron, in the distribution area of which the pain would be perceived. On the other hand, Donaldson believes that the peripheral branch of a spinal ganglion nerve splits, and that one of the branches is carried to the somatic distribution, while the other, through the ramus communicans, is distributed to the viscera. In this case, any irritation of the viscera would so alter the ganglion cell that, if the irritation were strong enough, it might give rise to pain; or if it were not severe enough to cause pain, it might produce such an alteration in the cell that a state of hypersensibility would ensue, and the slight irritation in its peripheral distribution would then be perceived as pain.

After the entrance of the sensory fibers into the cord, they are joined into well defined bundles, all the fibers of a single bundle having the same function. The fibers entering the posterior cornua may be defined as follows (May, 397, p. 759):

(1) Fibers which enter the post columns, and then divide into ascending and descending branches from each of these collaterals, pass at various levels of the cord and end in gray matter (Schultz Col., 130).

(2) Fibers which pass forward and end around the cells of the anterior horn (Edinger, 421).

(3) Fibers passing to Clark's column (Edinger, 421).

(4) Fibers which go to the cells of the posterior horn, lateral column, then end in the gray matter of the posterior column of the same side, but do not cross (Russell, 428, Mott, 429). These fibers terminate in the

medulla (post-column nuclei), but during "their course collaterals and some main fibers terminate in gray matter" (397).

(5) Fibers which pass to the post-column. 'Collaterals are given off and pass to cells of the gray matter, and end generally around cells of posterior horns. The fibers themselves terminate around cells in the posterior columns, and some extend as far as the columns of Goll and Burdach in the medulla (397, p. 760).

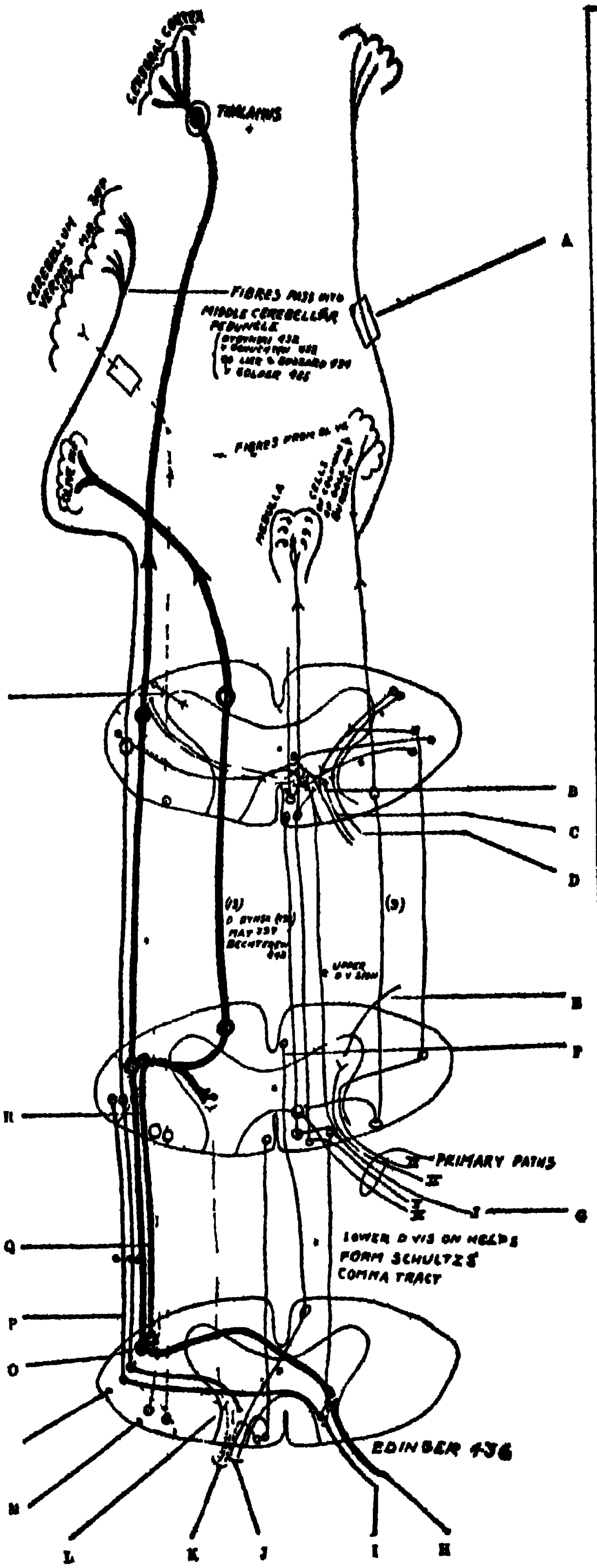
Fibers arising in cells of gray matter are:

(1) Fibers running in antero-lateral columns, same side.
(2) Fibers running in post-columns, same side.
(3) Fibers branching, one part running in the antero-lateral column of same side, and the other branch passing over in anterior commissure to run in antero-lateral column of opposite side.

The above are *primary paths*. *Secondary paths* are also present in the cord. They are represented by:

(1) Fibers which arise in Clark's column of the same side, and run to the dorso-spino cerebellar tract (path of Flick and Foville) lying exterior to the crossed pyramidal tract, and anterior to the post-root fibers. "In the medulla they are joined by a bundle of fibers from the crossed inferior olive, and pass directly into the restiform body, and thence to the cerebellum" (397, p. 763).

(2) The ventro-cerebellar tract forming part of Gower's tract, in which the fibers arise: (a) In the cells of the posterior horn and intermediate gray substance of the opposite side. (b) In the cells of the posterior column of the same side. Both pass up in the cord and brain, and terminate in the cerebellum.



S—Motor reflex from pain to a higher level on the opposite side.

R—Fibers giving rise to reflected pain in muscles.

Q — Transference pain to a higher level

P— Branch.

O—Tracheus spinothalamus tactalis

N—Ventral spino-cerebellar tract.

M—Dorsal spino-cerebellar tract

L—Clark scolumn

K—Muscle and joint sensation

J—Touch and pressure

A—Restiform body

B — Transference pain felt on both sides

C — Transference pain felt on opposite side

D—Pain felt on same side

E—Motor reflex same side as pain

F—Touch and pressure.

G—Transference pain

H—Pain.

I—Temperature

Fig. 9.—Diagram Showing Intraspinal Course of Sensory Fibers.

A—Pain from pricking burning freezing and electric current

B—Heat above 45° C

C—Cold below 20° C

D—Hair sensation

F—Light touch over hairless parts or parts which have been shaved.

F—Discrimination between compass points

G—Discrimination in size

H—Cutaneous localization

I—Temperature between 27° and 40° C

J—Pressure and pain from excessive pressure

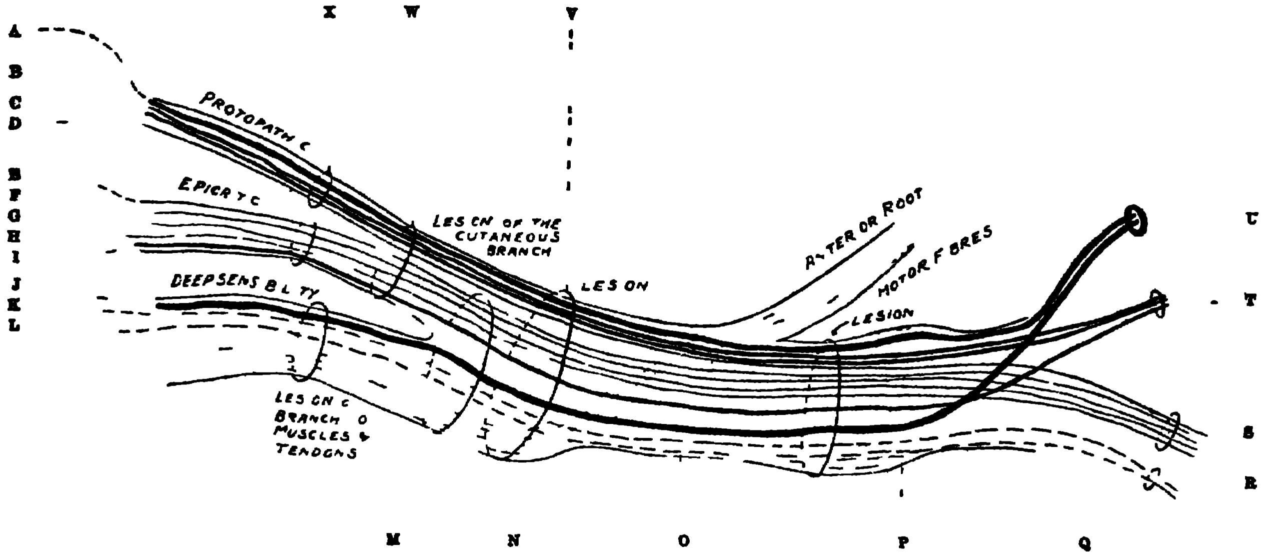
K—Muscle movement

L—Joint movement

W—Section here causes loss of sensation to all forms of superficial stimulation Sensitive to pressure Insensitive to light touch prick and temperature changes

X—Section causes loss of deep sensibility and produces muscular paralysis

V—Section causes muscular paralysis and loss of all sensation to the part supplied by the nerve The nerves supplying the muscles and tendons enter the tendons very high Therefore in injury of a nerve the muscle branches may be saved and thus in some cases convey sensation when the cutaneous nerves are paralyzed Sensation to light touch and moderate degrees of temperature are not abolished to the same extent as prick and extremes of heat and cold They also are abolished over a smaller area



M—Union of the epicritic fibers with those of deep sensibility and motor fibers

N—Nerve root

O—Post root

P—Posterior root ganglion

Q—Separation in cord into the different conduction paths

U—Pain

T Temperature

S—Touch

R – Muscle and joint sensation.

Fig 10—Course of the Different Sensory (Peripheral) Fibers, According to Head.

(3) The fibers of the tractus spino-thalamicus which arise in cells in the posterior horns, cross over in anterior commissure to the spino-thalamicus tract, and pass upward to end in the thalamus. Collaterals are sent to:

(a) The lateral fillet of the same side.
(b) The post-corpora quadrigemina of the same side and the opposite side.
(c) The anterior corpora quadrigemina of both sides.

The ascending path in the anterior column consists of:

(1) Long and short intersegmentary fibers, the exact origin and terminations of which are obscure.
(2) One set of fibers which arises from the lateral bundle, passes into the anterior columns, and thence up the cord to terminate in the inferior olive (May, 397, Dydynski, Bechterew).

Figures 9 and 10 will give a diagrammatic idea of the course of these fibers.

After passing through the mesial fillet the fibers enter the thalamus (May, 397, pp 789 791), from whence they are distributed to the cortex, some, at least, posterior to the central fissure of Rolando (397).

CHAPTER III

DISTRIBUTION OF THE SENSATION OF PAIN

The sensation of pain is either *deep-seated* or *superficial*. When *deep-seated*, it is carried, as a rule, by the nerves of deep sensibility from the tendon receptors. These are termed the tendon spindles (tendon organs) of Golgi (Howell, 539). They do not degenerate after section of the anterior roots, and therefore must be derived from the posterior roots and are sensory in origin (Sherrington, 540). They are particularly irritated by anything which disturbs the relationship of the subcutaneous structures, such as deep pressure, or the rolling of the tissues over each other. Pressure made on the skin, raised in a fold, the base being held tightly between the fingers, will not be felt. This shows that this type of sensation (pressure sense) resides in the deeper structures, the muscles and tendons (Strümpell).

Superficial pain (protopathic system) is carried by the cutaneous nerves. Here the pain fibers are associated with those carrying sensations of heat, cold, and light touch. These sensations are all separately received upon special nerve receptors, found in the skin in well-defined minute areas, each area being associated with a particular specific sensation. That the nerve fibers for temperature and pain are closely associated in the same nerve bundle is seen from the fact that, if either of them is irritated, the pain, if referred to a distant area, is felt in the same area (Rivers and Head, 86, p. 417). These local areas of sensibility, in which the pain fibers originate, "vary greatly in activity and threshold." According to von Frey, the pain points are those pain spots of lowest threshold in any particular area of the skin. Landois (541) states that the pain points do not coincide with the pressure points which are present on the same area, but are about one thousand times more numerous.

The *epicritic* differs from the protopathic system, in that it does not transmit pain, but seems to be concerned with the discrimination of the finer variations of sensation. It is the last sensory system to appear, being developed after birth. Following an injury to a cutaneous nerve, epicritic sensibility does not return until some time after the recovery of the other types of sensibility. For instance, pain returns before the sensations of light touch, warmth, coolness and the discrimination of two points of a compass. According to Head and Sherren (295, p. 163), the time necessary for the return of sensibility in the following systems after section of a cutaneous nerve is as follows:

	PROTOPATHIC		EPICRITIC	
	Begun	Completed	Begun	Completed
Ulnar, with dorsal branch intact ..	? days	133 days	183 days	320 days
Complete ulnar nerve.	109 days	171 days	169 days	278 days
Median nerve	65 days	190 days	262 days	387 days
Median and ulnar nerves	101 days	217 days	271 days	470 days

A peculiarity of pain sensibility is that, in the absence of thermal sensibility, a temperature between 40° and 44° C. will cause pain; but as soon as the thermal sense returns it requires a higher degree of stimulation to overcome the inhibition of the conveyance of the pain stimulus by the conducting apparatus normally resident in the part. The protopathic nervous system gives rise to hyperalgesia, but the areas of hyperalgesia derived from different nerves so overlap that they are useless as a means of defining the distribution of any peripheral nerve. On the other hand, the epicritic nervous system gives well-marked, delimited areas which may be used to define sensory nerve-distribution areas. This means of discrimination can only be used when the lesion is in the course of a nerve. When it is in the nerve root, the regions of distribution greatly overlap (Tigerstedt and Sherrington), so that the "lateral aspect of the body is provided with a twofold, or even a threefold nerve supply."

Pain Localization.—To *localize* pain, it is necessary that the sense of touch remain intact. When it is diminished, there is a tendency for the sensorium to refer the pain sensation to a part where the touch sensation is more acute. An aid which the patient instinctively uses, in his attempt to localize sensation, is motion. Let the sense of touch in a finger be dulled, for instance. One may then prick the finger, and the patient will not be able to tell from where the pain comes; but grant him the privilege of moving the finger, ever so little, and the touch upon his finger, and the pressure against it of the pricking object, will enable him correctly to localize the site of the irritation. This localization is explained in the work of Head and Sherrington (263, p. 185), who find that the muscles have a slightly different sensation from the skin, and also that the muscles are not supplied by the same nerve fibers which supply the skin, so that, by means of this involved muscular supply, a correct localization can be made. When a lesion is on the nerve circuit, a correct localization of the injury is made by means of the nervi nervorum, as in a case reported by Mitchell (263, p. 193), wherein "a blow had fallen on the ulnar nerve at the elbow. The pain was felt in the fingers, but there was also a well-defined sense of hurt at the point struck."

However, every portion of the body is not equally supplied with pain filaments. The abdomen seems to be most liberally supplied, then the chest, extremities, neck and back (Crile, 521). The structure which is probably the most sensitive to pain is the conjunctiva of the eye.

When the patient himself subjectively localizes a pain, one should always insist upon his being definite in his statements, and, if possible, have him indicate with his hand the area affected. In some cases, the pain occupies an extensive, but rather indefinite, area, so that the patient is unable to delimit it exactly. In these cases (Schmidt) the focus is generally at the point where the pain

A—Ext cutaneous (of thigh) (Br. lumbar plexus).

B—Ext cutaneous (of leg).
Ext popliteal

C—Musculocutaneous
Ext popliteal
Great sciatic

D—Ext or short saphenous.
Ext popliteal
Int popliteal
Great sciatic

E—Ant tibial
Ext popliteal
Great sciatic

F—Iliac br of iliohypogastric

G—Crural br of genitocrural

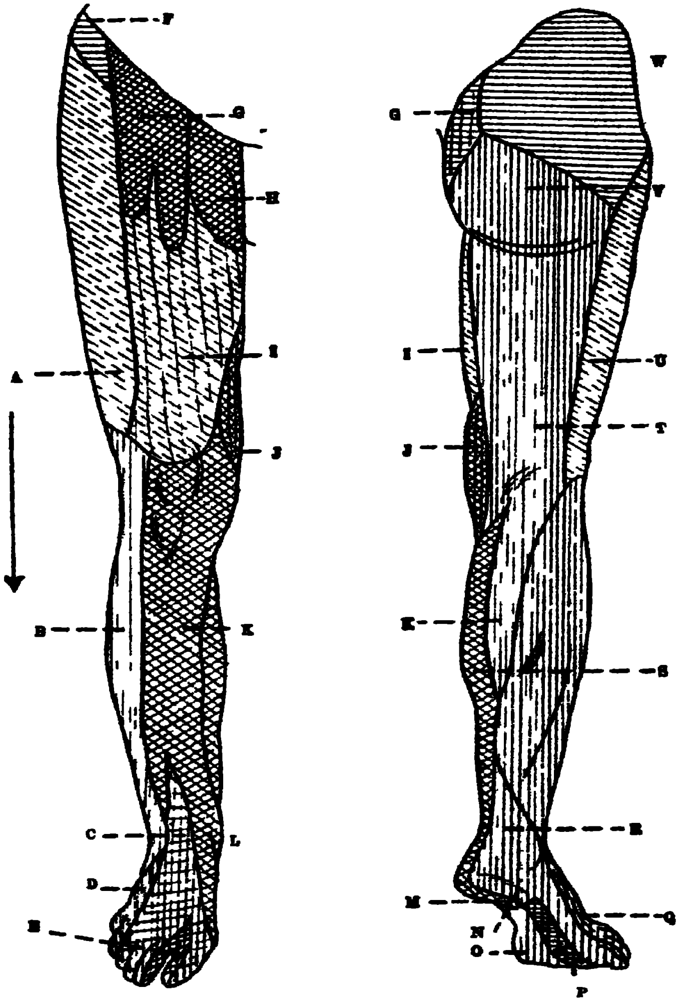
G'—Crural br o' sacral

H—Ilioinguinal and genital br of genitocrural

I—Middle and internal cutaneous (ant. crural)

J—Cutaneous br of obturator.

K—Cutaneous br of int or long saphenous (ant crural)



L—Int saphenous (ant. crural).

M—Int calcaneous.

N—Ext calcaneous.

O—Int plantar.
Post tibial
Int popliteal
Great sciatic

P—Ext plantar
Post tibial
Int popliteal
Great sciatic

Q—Musculocutaneous
Ext popliteal
Great sciatic

R—Ext of short saphenous.
Int and ext popliteal
Great sciatic

S—Ext cutaneous (of leg).

T—Small sciatic

U—Ext. cutaneous (of thigh).

V—Gluteal branches of small sciatic.

W—Cutaneous offsets of the ext branches of the posterior primary divisions of the first, second and third lumbar

FIG 11.—CUTANEOUS SENSORY NERVE SUPPLY TO THE LOWER LIMBS. (After Toldt)

first occurred (inflammatory pain). This is true only of local pains; other varieties will be described later in the text.

According to Tigerstedt, Pryer and Krause have asserted that the skin covering any given muscle is supplied with sensation by the same spinal nerve which supplies the muscle.[1] This was also a dictum of Hilton; but it has been shown to be untrue by Sherrington. He found that, during development, certain displacements occur, causing the skin regions to be situated somewhat more distally than the muscles with which they are related through a common nerve supply.

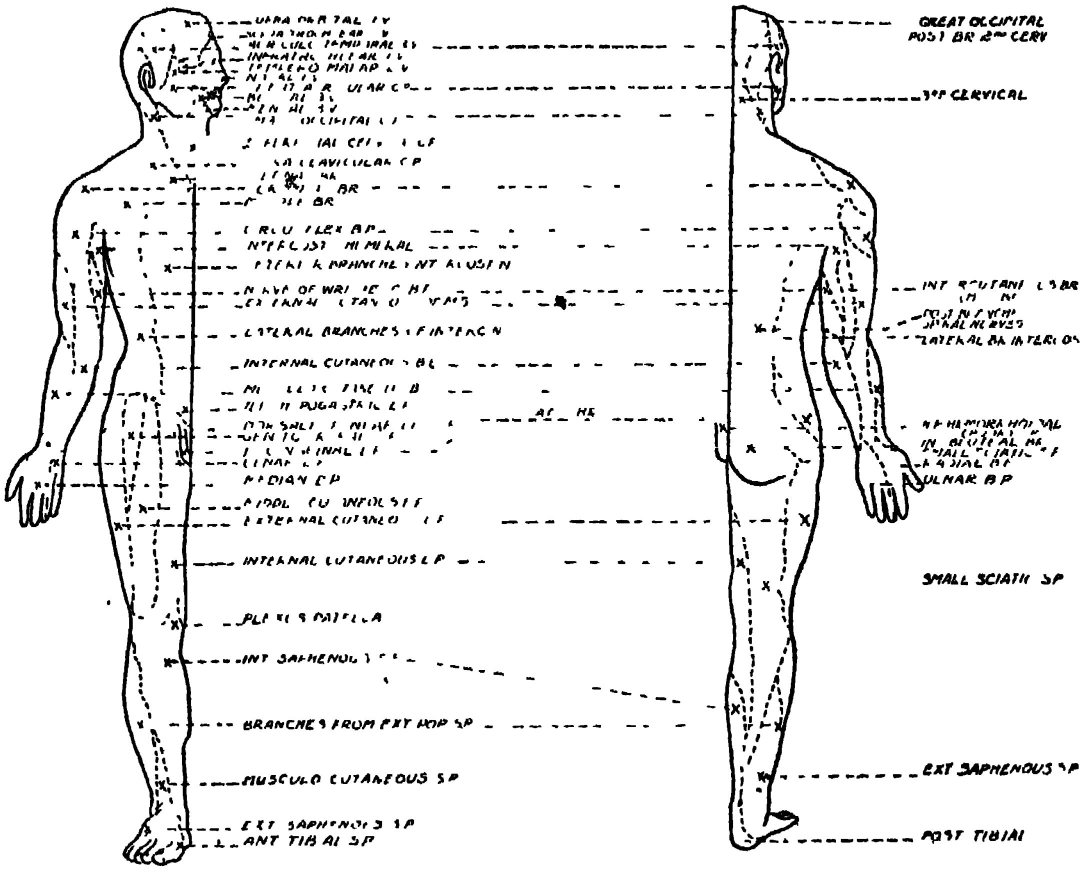


FIG. 12.—CUTANEOUS DISTRIBUTION OF PERIPHERAL NERVES. (After Fowler.)

The sensory nerves of a muscle probably belong to the same cord segment as the motor nerves of the same muscle.

In the *peripheral* distribution of the sensory fibers, four different areas must be defined, namely:

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[1] Tigerstedt gives the flexor surface of the thigh and foreleg and the anterior side of the arm as the only exceptions to this rule.

(1) The areas of distribution of the peripheral nerves.
(2) The areas of distribution of the different plexuses.
(3) The areas of distribution of the posterior roots and their corresponding segments.
(4) The areas of distribution of certain areas related to visceral disease, as defined by Head and his associates.

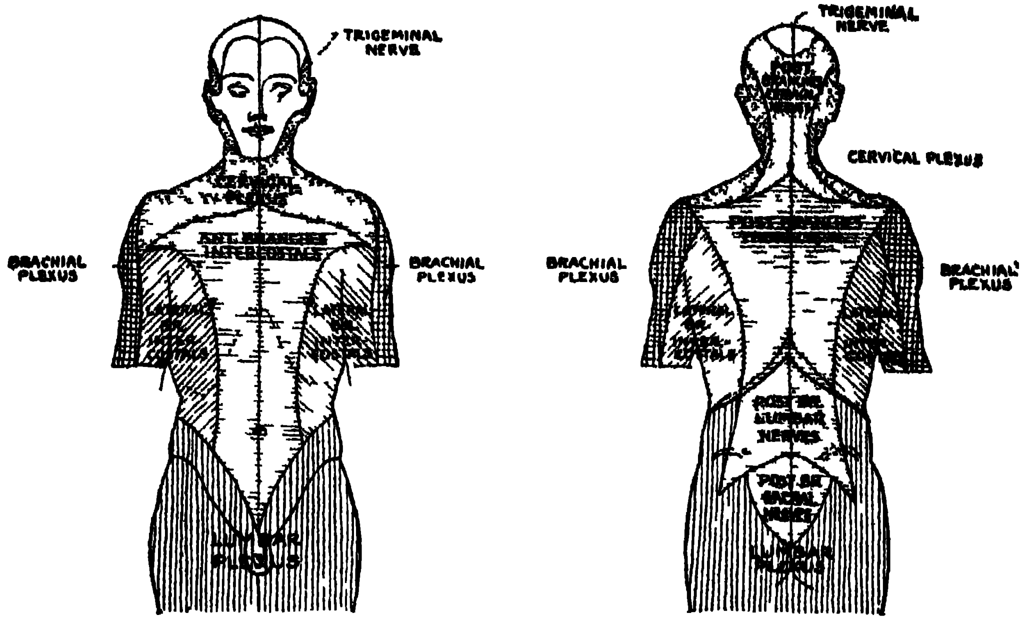

FIG. 13 FIG. 14

FIGS 13 AND 14 —CUTANEOUS NERVE SUPPLY, SHOWING THE DISTRIBUTION AREAS OF THE DIFFERENT PLEXUSES (Toldt, Part VI, p 811)

The area of distribution of the sensory fibers in the peripheral nerves, because of their overlapping, is rather difficult to outline. This accounts for the great variation in boundaries, as given by the leading workers in this field. Figures 13-17 are a composite of the description and the drawings (see figures) of the principal authors consulted.

Any lesion causing irritation in the course of a peripheral sensory (pain) nerve would cause the pain to be referred to the distribution area of this nerve. Care must be taken, however, not to allow the overlapping of the distribution areas to render the deductions misleading.

The distribution areas of the sensory fibers in the *posterior roots* and in the corresponding segments of the cord as given by

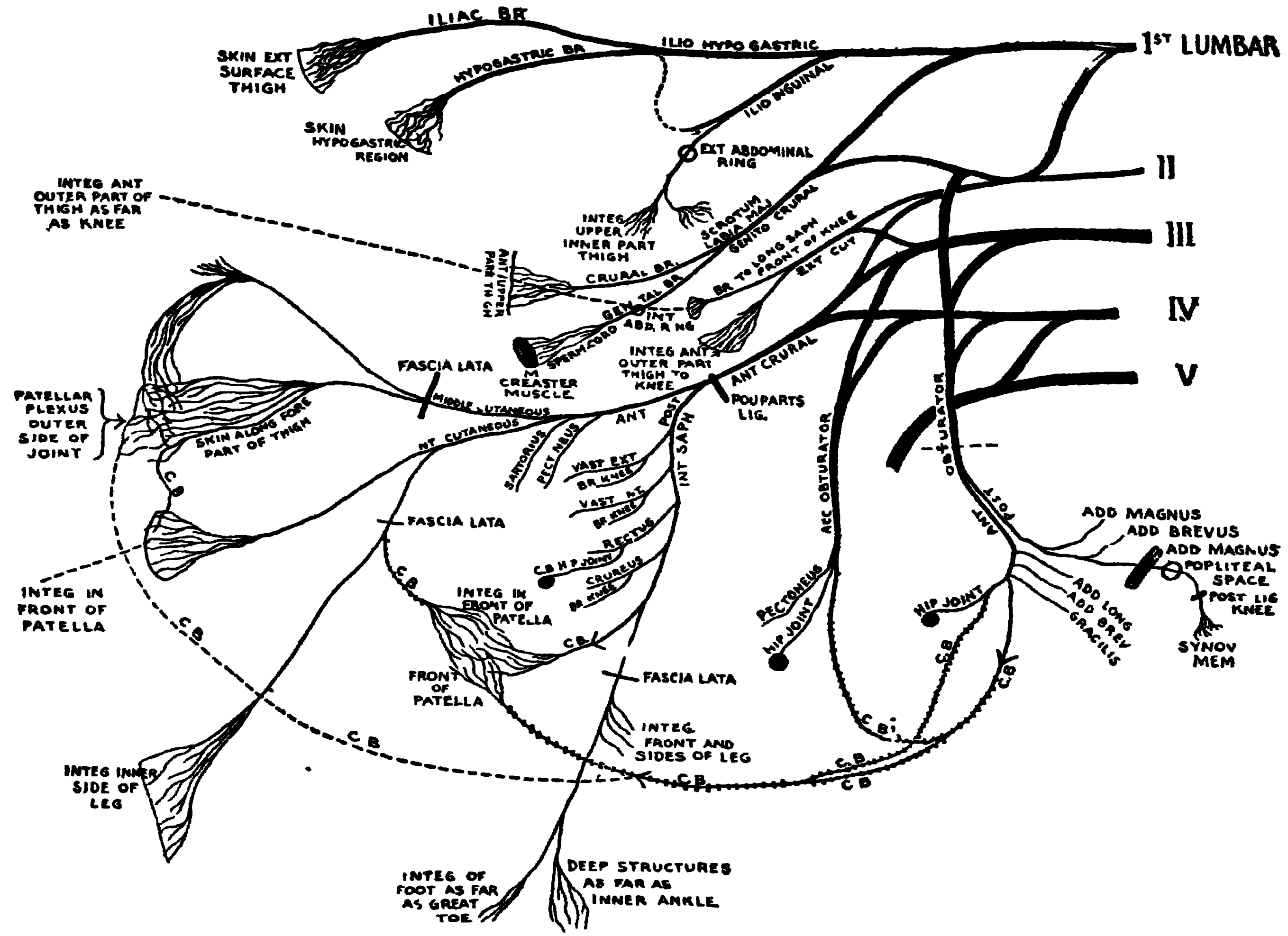

Fig. 15.—Distribution Areas of the Nerves (from Lumbar Plexus) Distributed to the Anterior Surface of the Thigh and Abdomen

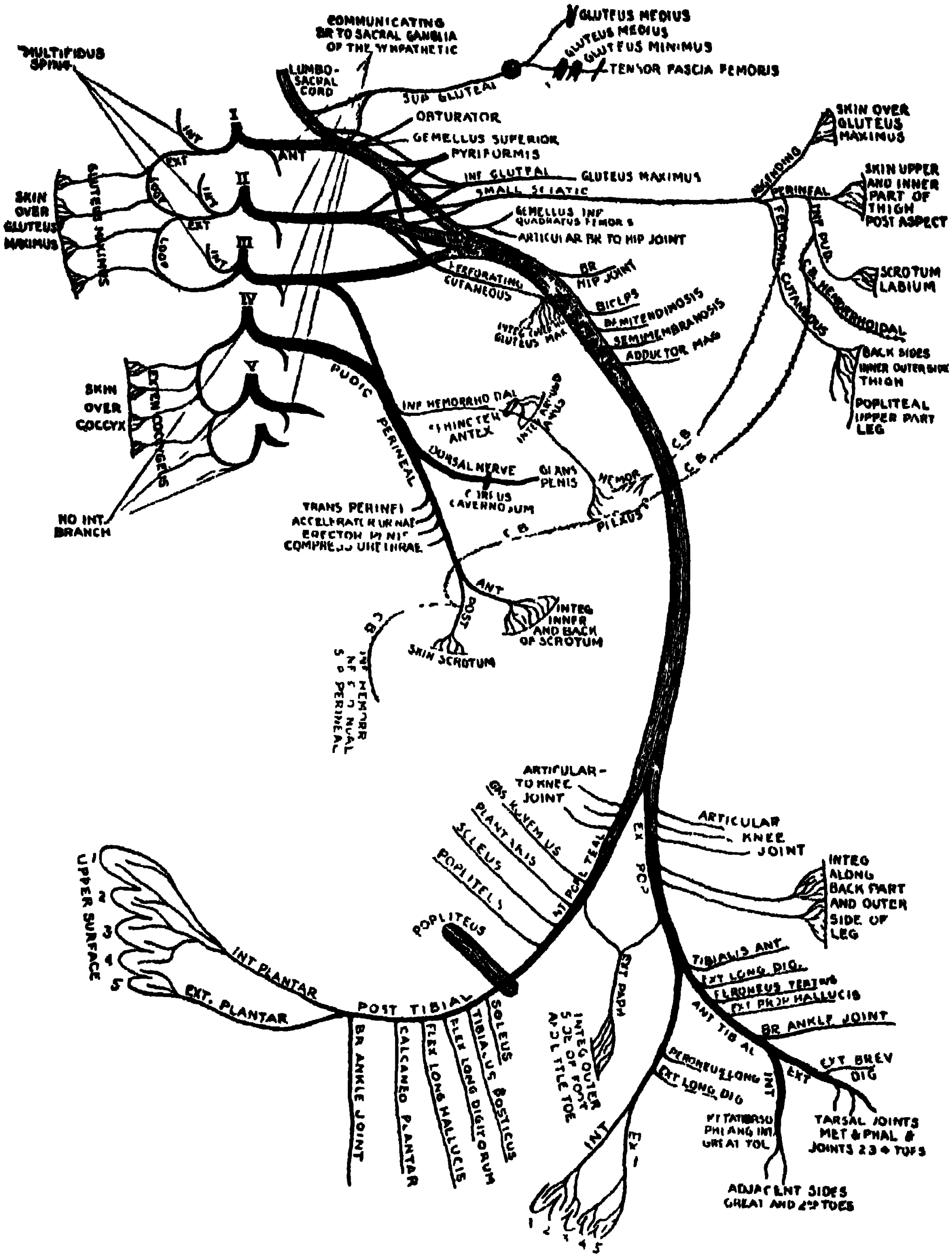

FIG. 16.—DISTRIBUTION OF THE NERVES DERIVED FROM THE SACRAL PLEXUS.

different authors, differ even more widely than do those of the peripheral nerves. The distribution, as given by Thorburn, Starr, and Kocher, is shown in Figures 18-23. Figure 23 shows the relationship between the cord segments and the different nerves.

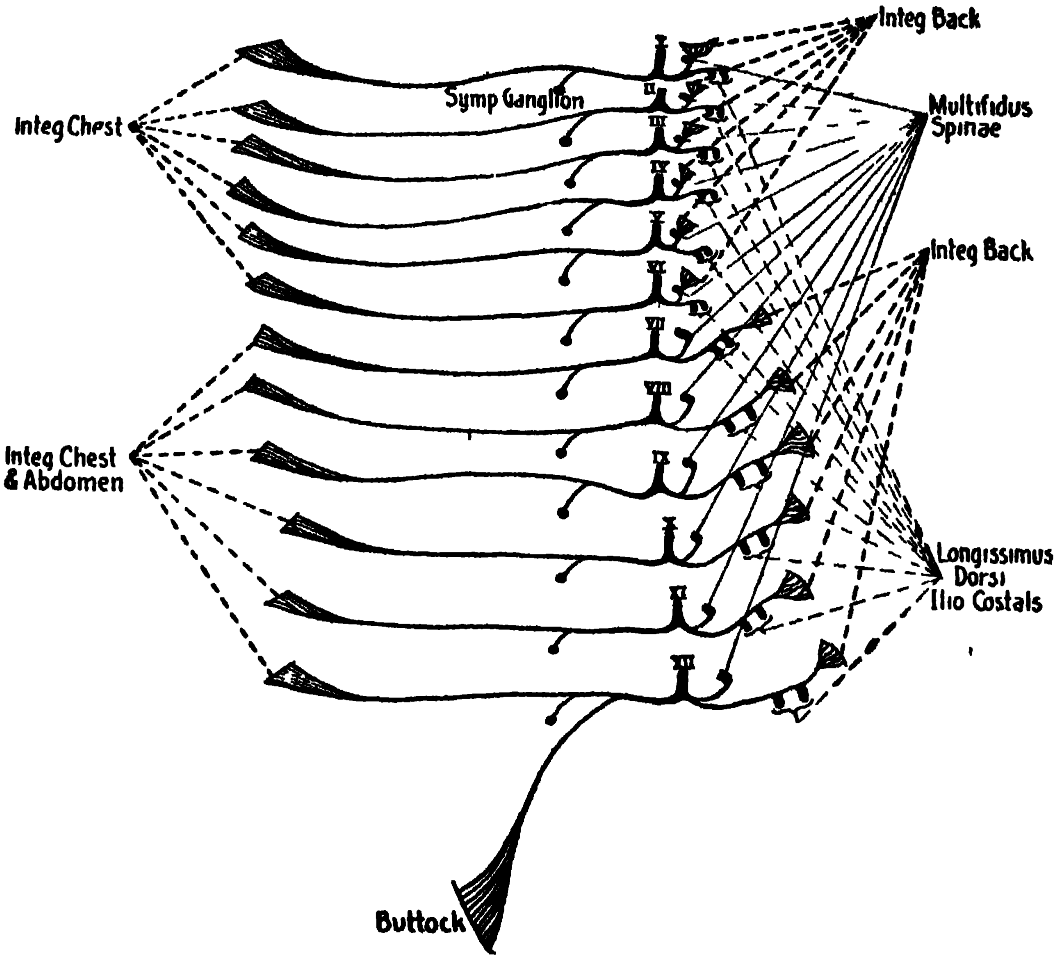

FIG. 17 DORSAL NERVES

There are also on the body surface certain well-defined zones which are related to visceral diseases; they were first described by Head, who, while working in the London Hospital, noticed that, in different diseases of the *viscera*, areas or zones of cutaneous hyperalgesia were found which coincided rather closely with the areas of distribution of herpes of the different regions. Since herpes was due to a disease of the posterior root ganglion (Head and Rivers; Church, 542, etc.), he concluded that in the ganglion certain stimuli must be transmitted from the visceral fibers to those going to the somatic areas, and produce an irrita-

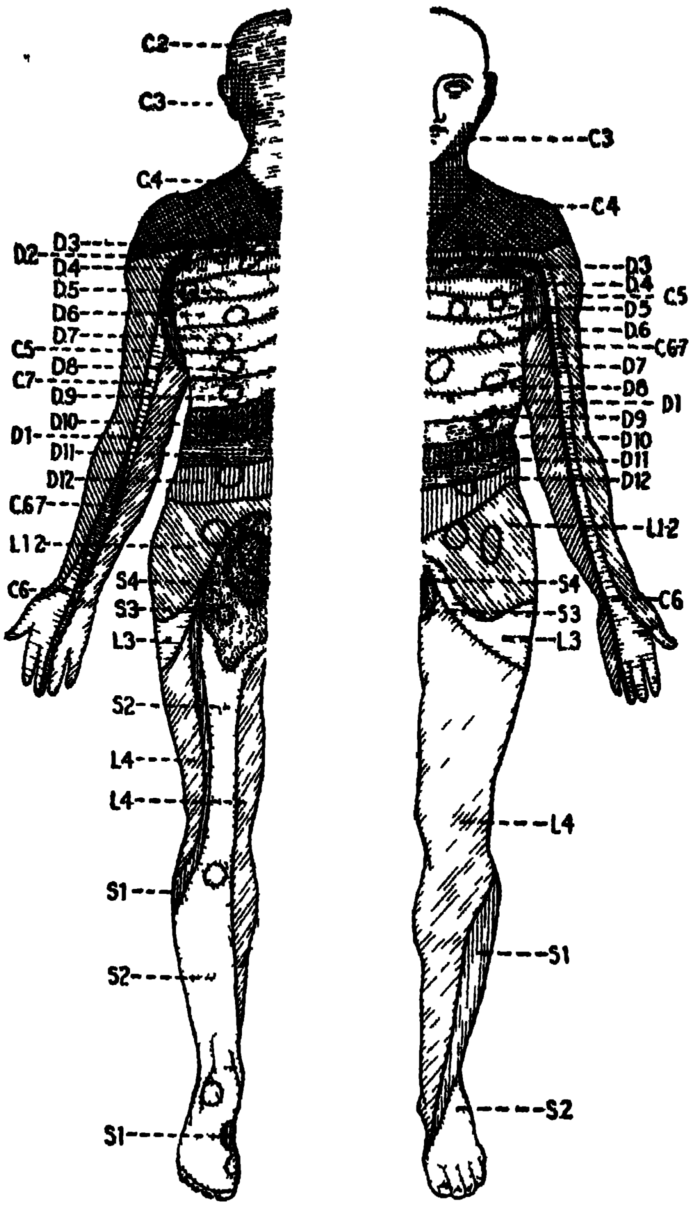

FIG. 18.—CORD ZONES ACCORDING TO KOCHER

These represent the cutaneous areas involved in lesions of different segments of the cord. The circles represent the areas of maximum tenderness according to Head. Head's zones and these do not entirely coincide because Head worked out his zones from a study of visceral lesions and somewhat arbitrarily defined them, while Kocher used the peripheral disturbances occurring in lesions of the cord as the means of defining his segments. These really represent the distribution areas of the posterior roots.

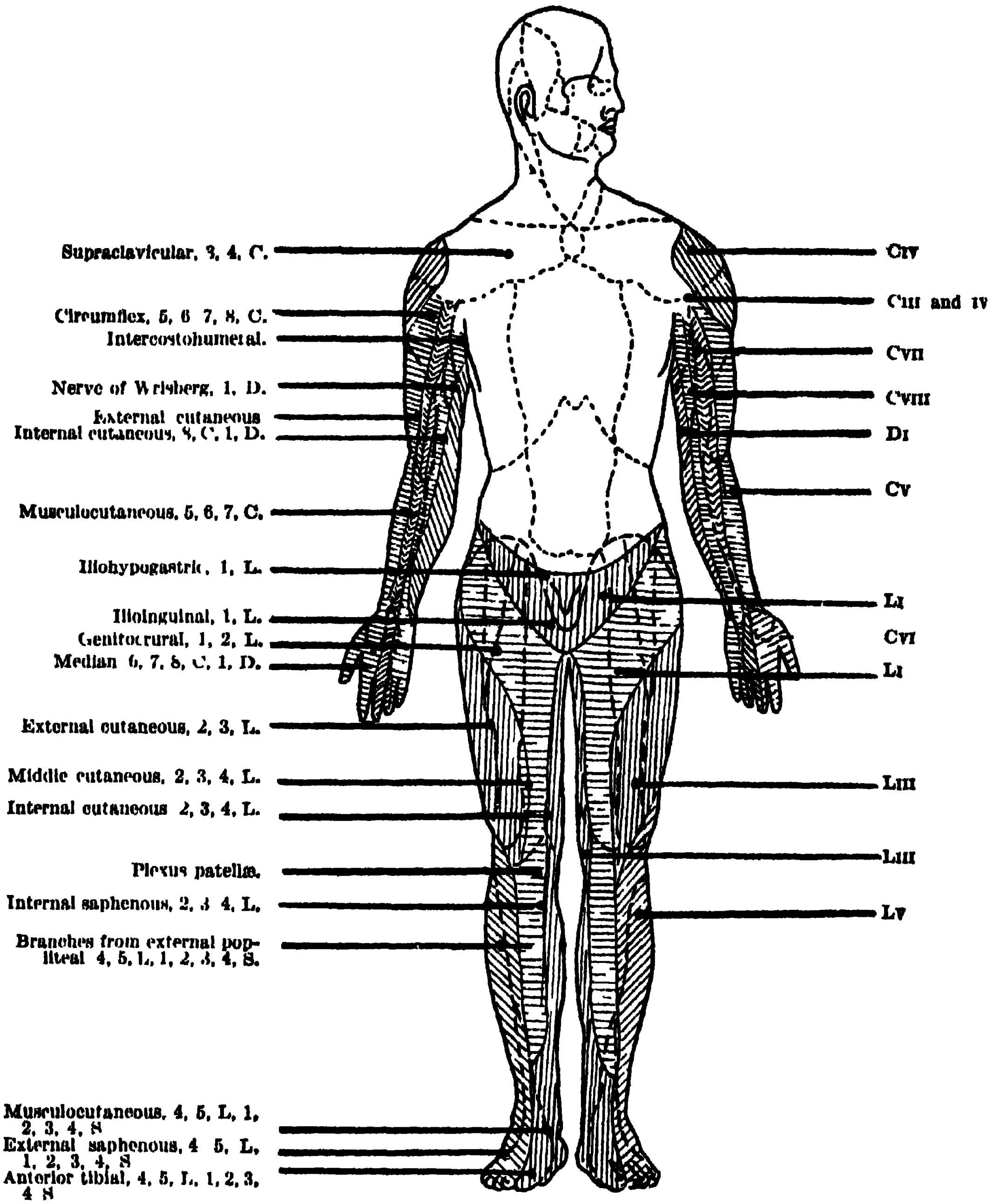
Supraclavicular, 3, 4, C.
Circumflex, 5, 6 7, 8, C.
Intercostohumeral.
Nerve of Wrisberg, 1, D.
External cutaneous
Internal cutaneous, 8, C, 1, D.
Musculocutaneous, 5, 6, 7, C.
Iliohypogastric, 1, L.
Ilioinguinal, 1, L.
Genitocrural, 1, 2, L.
Median 6, 7, 8, C, 1, D.
External cutaneous, 2, 3, L.
Middle cutaneous, 2, 3, 4, L.
Internal cutaneous 2, 3, 4, L.
Plexus patellæ.
Internal saphenous, 2, 3 4, L.
Branches from external popliteal 4, 5, L, 1, 2, 3, 4, S.
Musculocutaneous, 4, 5, L, 1, 2, 3, 4, S
External saphenous, 4 5, L, 1, 2, 3, 4, S
Anterior tibial, 4, 5, L, 1, 2, 3, 4 S
CIV
CIII and IV
CVII
CVIII
DI
CV
LI
CVI
LI
LIII
LIII
LV

FIG. 19.—CUTANEOUS AREAS RELATED TO SPINAL CORD SEGMENTS (Church and Peterson, p. 56, after Starr) AND CUTANEOUS DISTRIBUTION OF NERVES (Church and Peterson, p. 52, after Fowler).

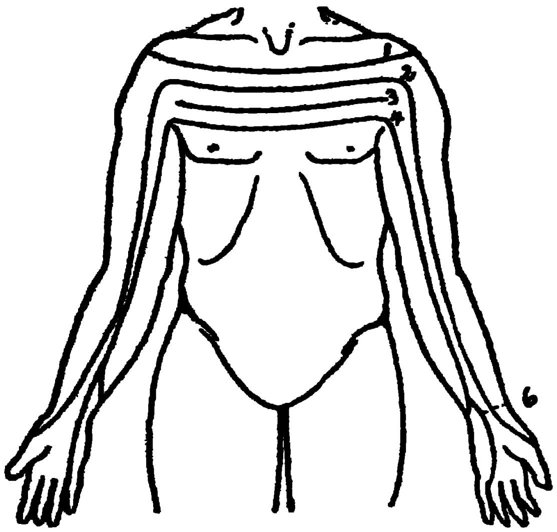

Fig 20—Areas of Anæsthesia and Paralysis Corresponding to Affected Vertebræ

Area below 1 indicates the area of anesthesia and paralysis occurring in a crush between the 4th and 5th cervical vertebræ. Area below 2 was affected by a lesion between the 5th and the 6th cervical vertebræ. Area below 4 was the result of a lesion between the 8th cervical and 1st dorsal, the 1st dorsal also being involved. Area below 6 was affected by a lesion of the 1st dorsal. (Thorburn, Brain, Vol. XVI, 1893, pp. 361, 362, 363, 364, 365).

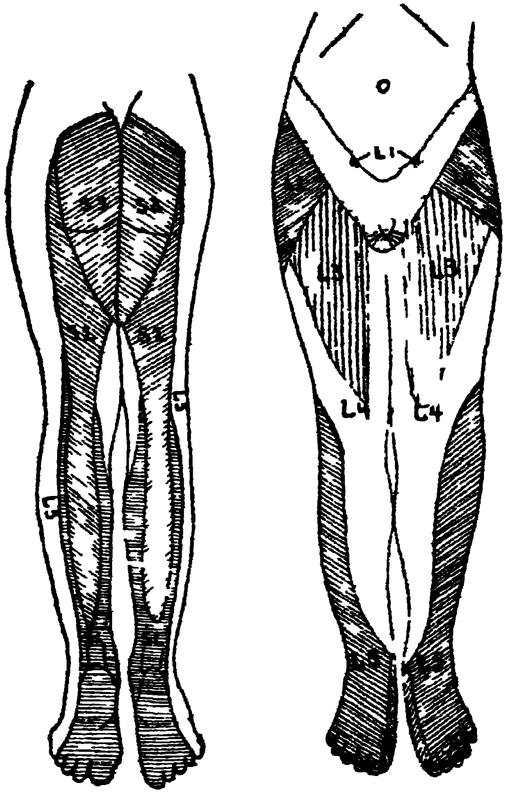

Fig 21—Distribution of the Lumbar Segments According to Thorburn (Brain, Vol. XVI, p 369).

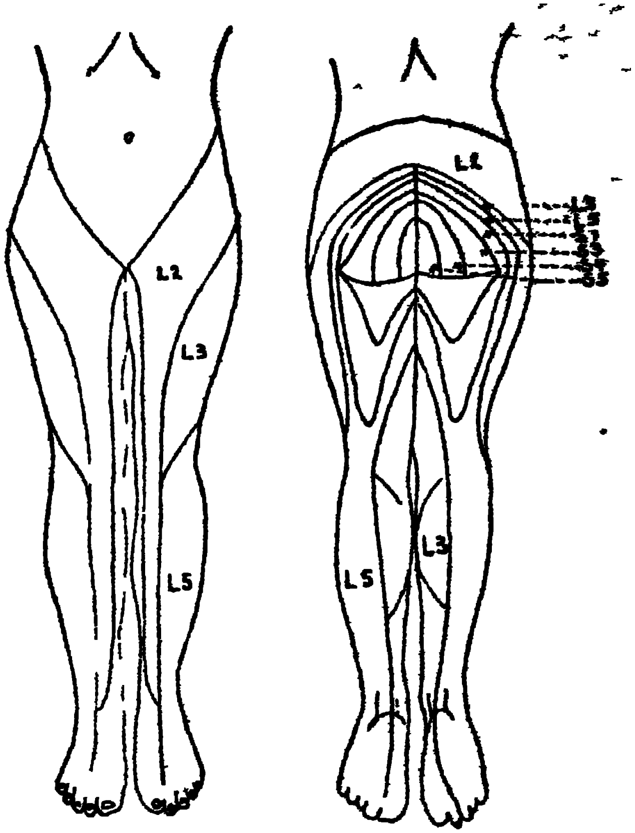

Fig. 22—Distribution of Lumbar and Sacral Segments as Outlined by Starr (Am Jour. Med. Sciences, 1892). These areas differ markedly from those outlined by Thorburn in Brain, Vol XVI, p. 355.

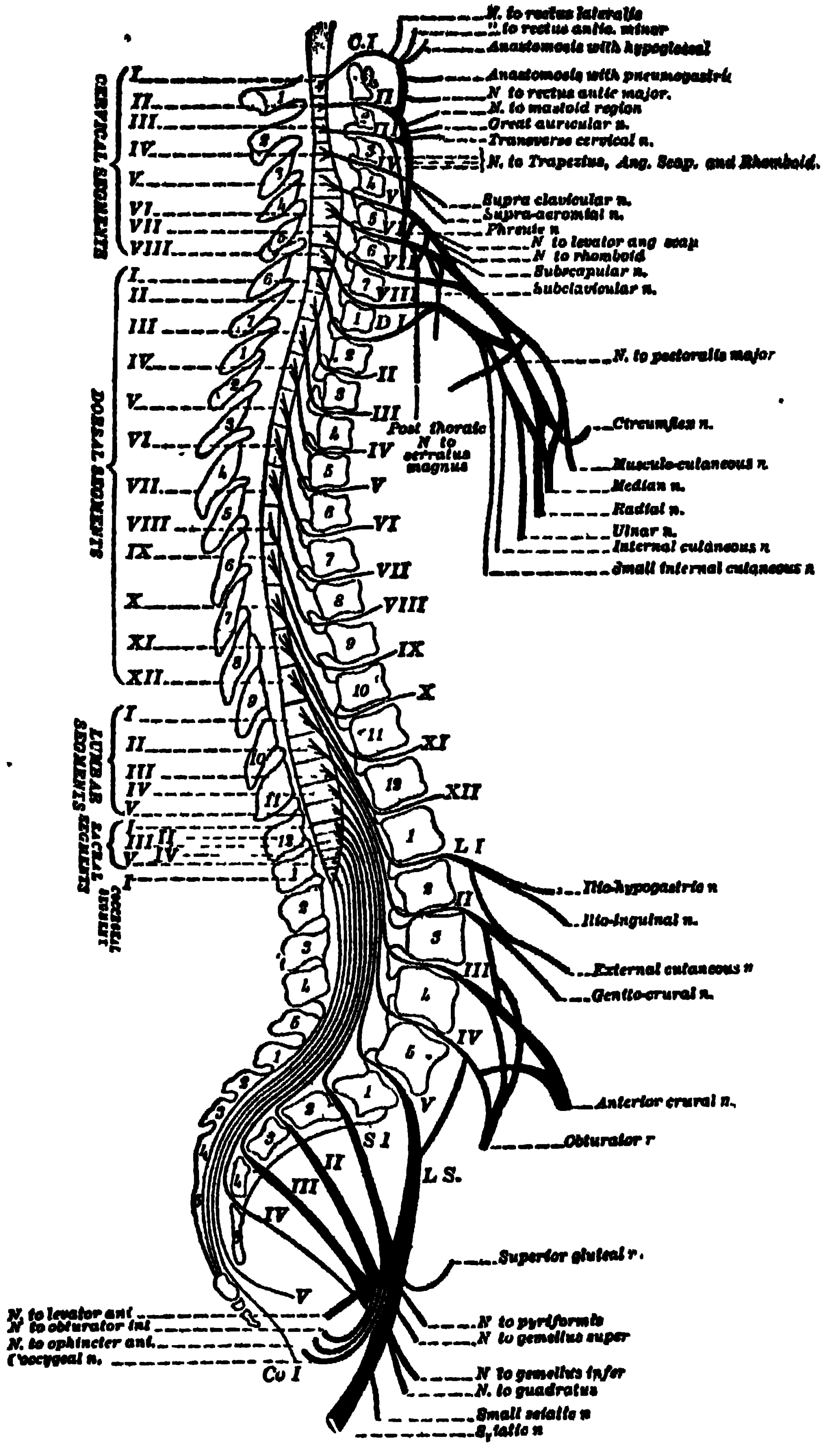

FIG. 23. -RELATIONSHIP OF THE SEGMENTS OF THE SPINAL CORD AND THEIR NERVE ROOTS TO THE BODIES AND SPINES OF THE VERTEBRA. This is the reason for the location of the distribution segments lower than one would naturally expect. (Keen's System, Vol. II, p. 843.)

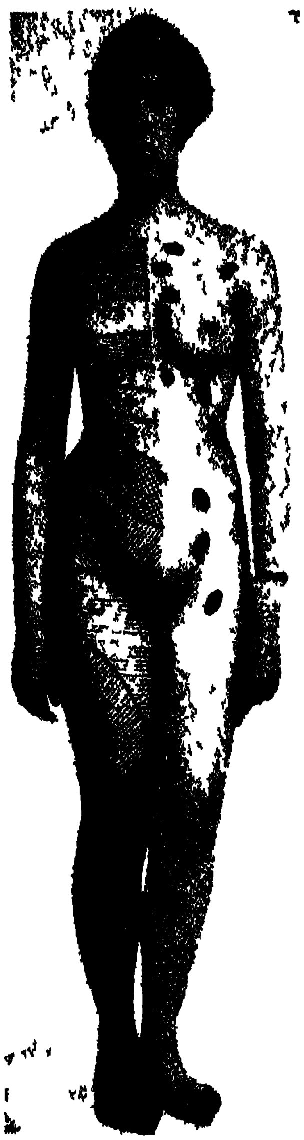

FIG. 24.—CORD ZONES AND AREAS OF MAXIMUM TENDERNESS ACCORDING TO HEAD.

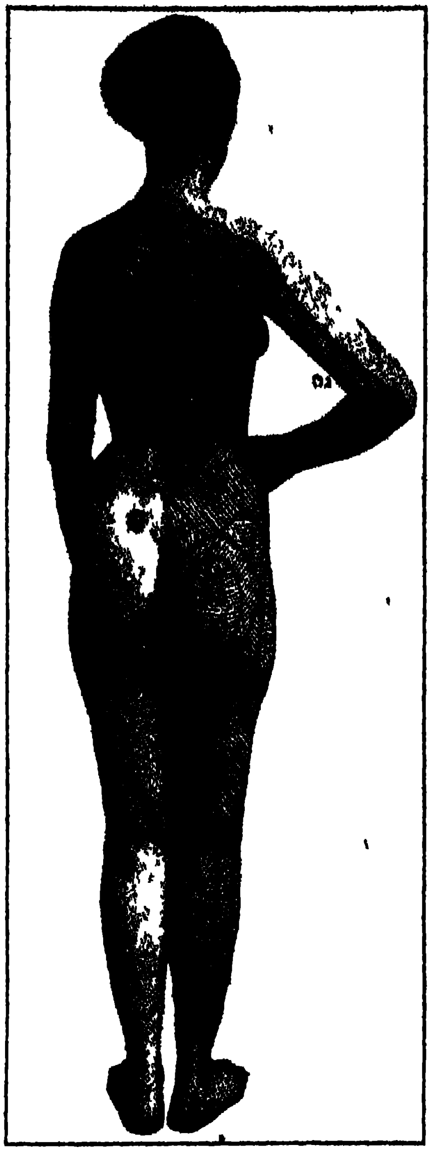

FIG. 25.—CORD ZONES AND AREAS OF MAXIMUM TENDERNESS ACCORDING TO HEAD.

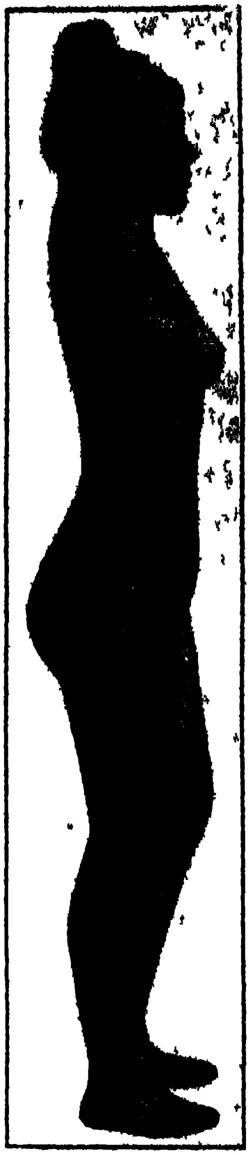

FIG. 26.—CORD ZONES AND AREAS OF MAXIMUM TENDERNESS ACCORDING TO HEAD.

tion of these fibers, so that lighter than ordinary stimuli give rise to pain. These areas are given in Figs. 24-26. At the present time, they are acknowledged, in the main, as correct; and while many have slightly modified the areas, the modifications are so slight and so varied that it has been thought better to reproduce the original drawings of Head.

CHAPTER IV

PERCEPTION OF PAIN SENSATION

There are two states of perception, or rather, degrees of interpretation, of pain-sensation, namely: (1) The condition or state in which sensation is almost or entirely absent, *anesthesia* (when the sensibility to pain alone is absent, it is called *analgesia*), and (2) the state in which sensation is more acute than normal, and in which the slightest irritation will produce a more pronounced reaction, or *hyperesthesia* (if the pain reaction alone is increased, it is called *hyperalgesia*). Intermediate between these two is a class of conditions producing symptoms not severe enough to be classed as *hyperesthesia,* but which, because of their peculiarity, cannot be classed as normal. These are the *paresthesias,* in which creeping sensations, etc., are present over a part.

Analgesia.—Analgesia may be either central or peripheral. When central, the lesion may be in the brain, or spinal cord. When it is in the brain, it may be either *endogenous* or *exogenous.* Endogenous analgesia is present during severe emotion, such as great joy, anger, and fear, as is seen in the disappearance of a toothache as soon as the patient enters the dentist's office, or the cessation of pain when the patient is in mortal terror. It may be present during arduous mental work which requires great concentration of thought, and also in states of mental exaltation, such as exhibited by religious zealots, examples of which are the Buddhist fakirs. In such cases, a perversion of sensation, from strong religious excitement, seems to have taken place, so that, while undergoing the most severe tortures, no pain is felt. Instead even a sensation of pleasure is experienced. Just what factors underlie this type of phenomena is far from being satisfactorily explained. Some have assumed states of localized anemia or hyperemia consequent upon variations in blood pressure. Others assume changes in the resistance to the passage of nervous energy in completing nerve paths. Others assume a "spill" hypothesis, namely, that emotional excitement lowers the tension in certain nerve paths, and thus drains off the sensory impulses, so that the nerve is not able to properly conduct the stimulus, and radiation takes place into the adjacent tissues. Again, others assume blocking processes which shut the sensory perceptions out of consciousness. Thought along these lines is in a state of flux. Nothing is definitely known.

TOXIC ANALGESIA.—Certain forms of toxemia are powerful in retarding the perception of pain. They produce a dulling of consciousness, varying all the way from cloudiness of intellect to unconsciousness. Such toxemias are found in many states and diseased conditions of the body, as acute infectious diseases, the terminal stages of malignant processes, uremia, acute yellow atrophy of the liver, etc. They are also present in cases of failing circulation, such as occur prior to death, in fainting, and after severe hemorrhage. This is hardly the place to speak of the mentally defective, who, because of retarded development of the perceptive faculties, are backward in their ability to experience pain. These states are found in idiocy. In psychoses of various types, also, the pain-perceptive centers are dulled.

VOLUNTARY ANALGESIA. In some cases, there seems to be an ability to inhibit pain perception, as is seen in a case reported by Witmer, of a "professional painless man." In this case, pins and needles could be pushed into the skin; also, he could hold a red-hot half-dollar in his hand without wincing, until it had burned itself deep into the flesh. Witmer, from a consideration of the circumstances of the case, believed that the subject inhibited the sensation of pain, and not its external manifestations; that is, that he did not perceive the pain, and was not stoically enduring it. The patient was possibly a syringomyelic. Many of us, by sufficient training, are able to inhibit the sensation of pain. According to Mitchell, some women remain for years without the peripheral pain sense, though the general health is unimpaired, while the internal organs are still sensitive to pain, and all forms of skin sense are as keen as ever.

The *extrinsic or exogenous* causes acting to produce analgesia are all those conditions which produce a lowered pain perception. Chief among these are drugs, morphin and ether probably taking the highest place among them. Both act by obtunding consciousness, although either may cause analgesia before consciousness has entirely disappeared.

Anesthesia.—It is often a subject of controversy whether or not a patient feels pain while under an anesthetic. It seems foolish that such a controversy should arise, when we know that pain is a concept of the higher sensorium, and that as soon as consciousness is dulled the sensorium becomes inactive, and the body is unable to perceive pain, although it may be able to perceive touch. To illustrate this, I will recount a little personal experience of several years ago. After using ethyl chloride successfully upon a patient, Dr. Henry Hall suggested that I try some. This I did, and after a few seconds the surroundings seemed to become distant, and, while I could see and hear, I was unable to move. When the doctor touched me and asked me to tell him when he did so, I was unable to intimate by word or gesture that I did not feel him, although I could see him touching me.

Anesthesia is in reality an *inhibition of perception.* The physiologists are agreed that the first phenomenon which is abolished during anesthesia is that of voluntary movement, after which come the loss of spinal reflexes, loss of pain, and finally loss of consciousness. It is also agreed that loss of pain-perception precedes, by a noticeable interval, loss of consciousness. Crile is not in accord with this, for he believes that the only result of an anesthetic (ether) is obtunded consciousness. The disturbing stimuli from the irritated area are carried to the brain, just as though the patient were conscious, and exert the same irritative action. The only difference is that the patient is not aware of their presence.

Interference with the areas of pain-perception will also cause a loss of pain-perception. This is seen especially in all those cases in which pressure is made upon the pain-centers, as in tumors, hemorrhage, or pressure from a depressed fracture of the skull. A case of this kind was reported by Leszynsky (550), in which, after a fracture of the skull, there developed, along with motor symptoms, an anesthesia extending around one leg. It resembled an hysterical anesthesia in that its boundaries were transverse, and did not in the least resemble the boundaries of the areas of distribution of either the peripheral sensory nerves, the posterior roots, or the cord segmental zones (Fig. 27). In this case, "there was an area of complete anesthesia, extending from the toes to about two and a half inches below the patella anteriorly, and to about three inches below the popliteal space posteriorly, with a circular band of dissociated sensory disturbance above this. For two inches above the level of the complete anesthesia, the tactile and temperature sensibility were abolished and the pain-sense was preserved. For one inch and a half farther up, thermoanesthesia persisted without impairment of other forms of sensibility. The patient stated that about one week before entering the hospital he noticed beginning loss of sensibility in the leg, and that about two weeks later the loss was

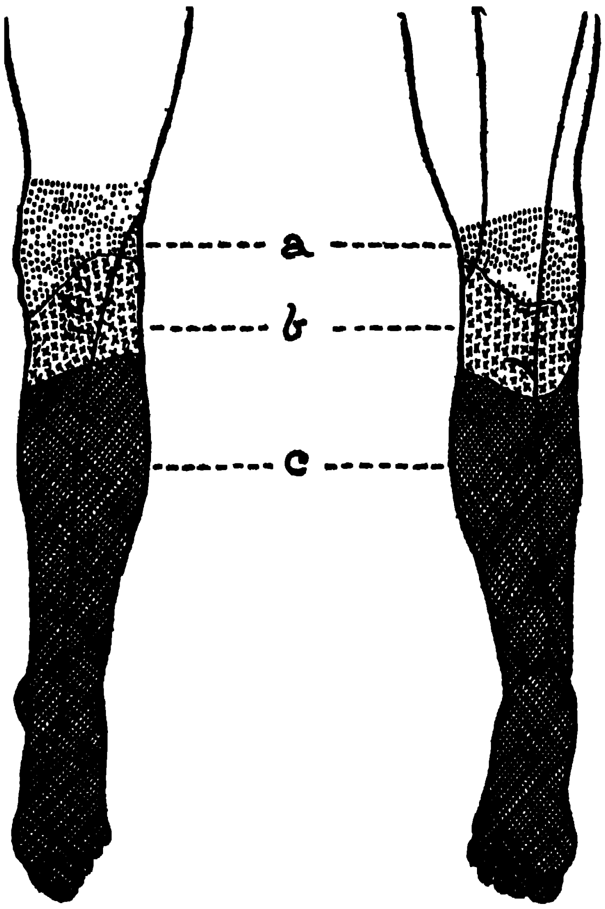

FIG. 27.—AREAS OF ANESTHESIA ON LEG DUE TO DEPRESSED FRACTURE OF SKULL.

a. Thermoanesthesia; *b.* tactile and thermoanesthesia; *c.* complete anesthesia.

complete. The loss of sensibility to the application of the faradic wire brush extended from the toes to about three inches below the level of the area of complete anesthesia. The senses of position and of localization were normal in the toes and foot. The senses of localization and of pressure were absent in the leg. The upper extremities and the other lower extremity were normal. There was no astereognosis. The visual fields as measured with the perimeter were practically normal." This case brings the point prominently to the mind that there are areas in the cerebral cortex which are connected with the sensory distribution of different regions of the body. This is important in the etiology of hysteria.

Paresis frequently gives rise to anesthesia, which, according to Clouston, is due to loss of inhibition (?) in the cortical areas. It would seem more likely, from the pathology of this condition, to be a loss of perception in the cortical areas.

Passage of an electric current of 1,000 volts through the body will cause anesthesia, probably due to encephalitis causing inability of centric perception (Hoover, 554).

The peripheral causes of anesthesia are all those conditions arising in the nerve pathways which act as obstructions to the onward progress of the pain stimulus, chief of which, of course, is severance of the pathways by section of the nerves or spinal cord. This may be the result of accident or of design, excepting that, in the case of the cord, it is never in man the result of design. In some cases the peripheral nerves are sectioned by the surgeon in an attempt to cure neuralgia. This is an operation which formerly was frequently performed for trifacial neuralgia. Broken back (fracture of the vertebra) frequently acts as an interrupter of conduction, though, unless it is accompanied by a dislocation, it generally does not cause a complete severance of the cord; so that the anesthesia may not be symmetrical nor complete. *Cord tumor,* however, is almost invariably accompanied by anesthesia. Indeed, Bailey (544) says that no cord tumor can be diagnosed with certainty if sensibility is intact. The only exception Bailey makes is in tumors of the cauda equina. *Syringomyelia* frequently produces changes which interrupt the conduction of touch, pain, and temperature. In other disorders, as in *transverse myelitis,* a local interruption of the sensory tracts in the cord also results in anesthesia. In *tabes* the sensory fibers are affected just as they enter the cord, and analgesia is produced here, although touch and temperature conduction may remain intact. Practically the only lesion of the posterior roots which causes anesthesia is severance, which generally occurs as the result of fracture of the vertebra.

Lesions within the nerve itself may cause an anesthesia. Anesthesia may also be the result of pressure within the nerve sheath, as illustrated in the case cited by Babcock (549), of a patient who had sustained a small incision of the median nerve from a piece of flying glass and had an area of anesthesia corresponding to the sensory distribution of this nerve. On exposure of the injured nerve it was found that it was not divided, but was the seat of a marked fusiform enlargement. Upon incision of the affected area, a gelatinous, serous fluid flowed from between the nerve fibers. A free longitudinal incision was made into the nerve. Four days later, upon testing the hand, it was found that the area of anesthesia had decreased one-third, and that there was a distinct increase in the ability to flex the fingers.

Should a nerve trunk be pressed upon by a tumor, a complete interruption of the conduction of nervous impulses may occur, and the area of skin distribution cut off will lose all sensibility. At the same time the irritation occurring at the level of the lesion may cause severe pain, which is referred to the peripheral distribution of the nerve. A similar condition, called *anesthesia dolorosa,* is often associated with cancer of the spine, the mass pressing upon and irritating the sensory nerves entering the intervertebral spaces (Eichhorst, 553, Landois, etc.).

Freezing of a sensory nerve trunk also causes anesthesia. This is due to ischemia because, when ischemia is present in a part (Kofman, 478), anesthesia generally results. This, in turn, may be a result of mechanical pressure or of a chemical reaction to toxic factors. In the *Glasgow Medical Journal* of 1898 (Vol. I, p. 467) are mentioned the following instances of operative procedure without pain, the only anesthetic measure being the production and retention of complete ischemia by means of an Esmarch bandage. By this method, a ganglion was resected from the dorsum of the right wrist without pain, a needle was also removed, and a ganglion in the popliteal region was resected. In such cases it is necessary that the ischemia be complete, and that a short time shall elapse between the application of the Esmarch and the beginning of the operation.

Certain *toxic agents* (as cocain) will produce a terminal anesthesia. Cocain first destroys the pain-conduction power of the fiber, and finally touch sensation. In the tongue, according to Schree (201, p. 207), the order in which sensation is lost in general anesthesia is taste (bitter, sweet, then acid), pressure localization, and lastly tactile perception. Temperature sense is also abolished (Mettler, 505). Carbolic acid (5 per cent. solution on the tongue) weakens the sense of pressure and pain, but destroys the sense of taste and temperature. Arsenic and belladonna produce anesthesia to touch and pain, but not to temperature. Saponin produces anesthesia to touch, but does not affect pain in any way (Rebot, Mettler, 505).

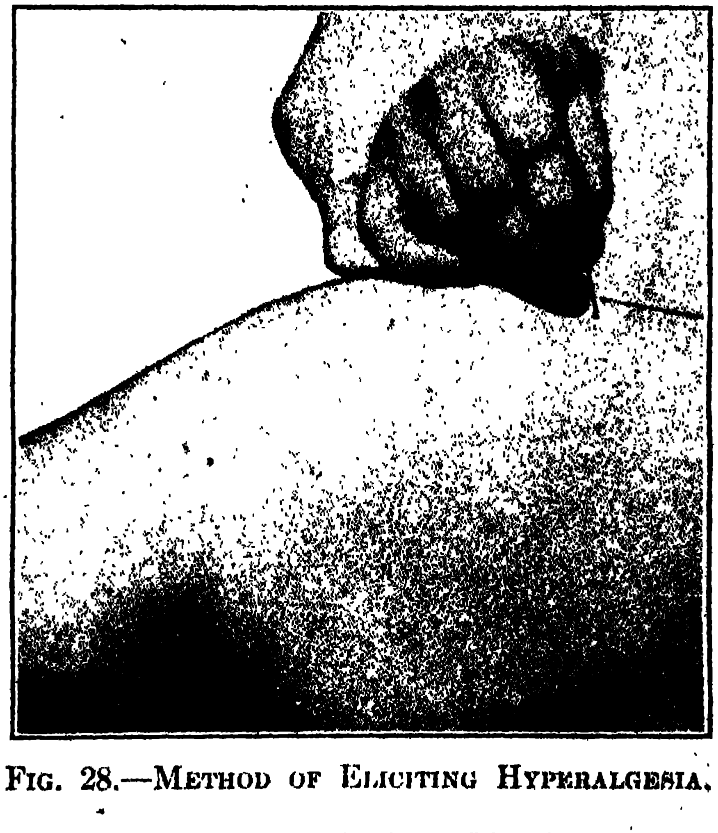

FIG. 28.—METHOD OF ELICITING HYPERALGESIA.

Hyperalgesia is a condition in which there is an abnormal painful sensibility to irritative processes of any kind. Since pain-perception is the specific performance of a definite kind of nerve fiber, hyperalgesia may be regarded as a hypersensitiveness of the pain nerves (Sahli, p. 771).

Hyperalgesia of a part may be tested in three ways:

(1) A rather sharp pin, or pointed instrument, is drawn across the surface under examination, the instrument being preceded by the finger, as shown in the drawing. The reasons for the finger preceding the instrument are: (a) that the sense of touch may be somewhat removed, in order that the patient may not be so likely to confuse touch sensation with pain sensation, and (b) that, by using the second finger as a support, more equable pressure with the pin can be made, while at the same time all folds of the skin which might cause inequality of pressure will be pressed out.

(2) A second method, in which the skin is pinched between the fingers, is also a good one, but does not show the slight changes in sensibility which are found by the first method; nor does it permit of such fine judgments on the part of the patient as to the presence or absence of pain, or of variations in the degree of pain, because of the inability of the examiner always to exert the same amount of pressure in each individual pinch. As far as personal choice goes, I have always preferred the first method.

(3) The head of a pin is sometimes used instead of the point. This really gives one hyperesthesia instead of hyperalgesia, hyperesthesia meaning an increased sensitiveness to all sensation, and hyperalgesia meaning only an increased sensitiveness to pain.

(4) Instrumental.—Various forms of instruments (esthesiometers, or algometers) have been devised for the purpose of accurately recording changes in sensory or pain perception.

In judging of the hyperesthesia of a part, special attention should be paid to each of the tissues composing the part, namely:

(1) The skin (hyperalgesia sought by running the point of a pin over the skin).

(2) The subcutaneous tissues (hyperalgesia sought by grasping lightly the structures of the skin between the thumb and first finger).

(3) The muscular tissues (hyperalgesia sought by movement of muscles).
(4) The osseous tissues (hyperalgesia sought by deep pressure and tapping).
(5) The serous membranes, such as the pleura or peritoneum (hyperalgesia sought by deep pressure, respiratory or cardiac movement). (McKenzie.)

The areas of hyperesthesia of any two of these tissues may not be coextensive. The area of tenderness of the subcutaneous tissues is generally more extensive than the areas of any of the other tissues. Sometimes the areas of the subcutaneous tissues which are sensitive may be at some distance from the hyperalgesic areas of the skin. This is explained by the fact that both of these areas are supplied by nerves coming from the same segments of the cord, but having different distributions (McKenzie).

Head has made a special study of hyperalgesic zones of the skin; that is, hyperalgesia due to pricking with a sharp instrument, or by pinching a fold of skin between the fingers. Should the underlying tissues be grasped, or pressure be exerted upon them, the results of the examination are apt to be deceiving, from the fact that the sensibility of the subcutaneous tissues is mixed with that of the skin. A reflex associated with these hyperalgesic zones is *dilatation of the pupil.* When the irritation is severe enough to cause pain, this dilatation is especially noticed on the side which is hyperalgesic. Pinching of the areas which are not hyperalgesic may, if the pinching is severe enough, cause a dilatation of both pupils, but more marked on the side pinched. The hyperalgesic areas are particularly insensitive to deep pressure. In many cases touch is not painful, while in others it produces the most severe pain. Deep pressure over these areas will also produce a dilated pupil more pronounced on the affected side. In these areas the sensations of heat and cold are also exaggerated.

These hyperalgesic areas are sharply defined, while the hyperalgesic areas due to a lesion of a nerve or nerve trunk are rather vague and indefinite, and overlap. As a consequence, they cannot be used to delimit the boundaries of nerve distributions. The mere fact that these areas of hyperalgesia (Referred Pain, Head) and of extremes of temperature (Forsyth, 26, p. 173) do not overlap, seems to show that they have their origin in the cord, and bear some relationship to the pain pathways, or at least that they arise in the spinal ganglion before the nerve roots unite and form plexuses, for it seems that it makes no difference how many nerve plexuses and nerves the spinal roots form; the areas of hyperalgesia are still distributed on the body in a segmental form. This is well illustrated in injuries of the spinal roots, or of the cord. Langley (131, p. 235) thinks that a slight rearrangement is required in Head's areas, in order to bring the anatomical and clinical evidence in accord. He says that "a white ramus always has sensory fibers." If so, it could carry sensory impulses, which would be so interpreted by the brain. We will not discuss this further, but will leave it for consideration under Sensibility of the Internal Viscera.

In some cases of anemia, malaria, and infections of various kinds, painful areas are present in the skin. This is particularly true of influenza, which sometimes causes a severe general hyperesthesia; so much so that the slightest touch is painful. The scalp may be so affected that the combing of the hair is almost unbearable. In some cases lesions of the internal viscera give rise to no hyperalgesia until an intercurrent infection, such as pneumonia, or possibly appendicitis, occurs. This increases the irritability of the cells in the cord, and then the irritation from the diseased focus is felt and is referred to the peripheral distribution, and continues after the intercurrent affection has disappeared.

Hyperalgesia and hyperesthesia do not increase the accuracy of localization. Rather, they seem to multiply and duplicate the number of sensations (Mettler, 505), so that the patient, on attempting to delimit his pain areas, becomes greatly confused.

Tenderness.—Tenderness is slightly different from hyperalgesia. It means a painful condition produced by pressure. Hyperalgesia, when severe, will also give rise to tenderness, but it may also be present and not give rise to pain on pressure. In some cases, even a strong, firm pressure is found most gratifying. Sometimes there is a dissociation between the tenderness and the subjective pain, the tenderness being present over the site of the lesion, while the subjective pain may be limited to this area or may be referred to a distant area.

As a rule, pain of equal intensity cannot be felt in two places at the same time, for the mind is capable of only a single impression at one time. Then, it will be asked, how are we aware of the pains over different parts of the body during the course of certain diseases (as influenza)? The answer is very simple. As no stimulus can always maintain the same intensity, at times its strength will be reduced. At such a time, another and lighter stimulus will gain the ascendency, and will impress its location and character upon the brain, and be perceived. This perception lasts only a short time, when the first, or some other, stimulus again gains the ascendency and impresses its character upon the mentality. Thus the localization of the pain varies, from day to day, from hour to hour, and from minute to minute, the stronger impression being the only one of which the mind is cognizant. This also accounts, in some instances, for the variability of pain, and for its frequent change of location. In other cases, the tenderness may be felt in a part distant from the lesion. This is particularly true when disease or pressure on a nerve is present. When such is the case areas of tenderness are generally at the points where the nerves emerge from the deeper parts and become superficial. To them the name Valleix's points has been given.

According to Bennett (475), there are three *painful reactions to pressure.* In the first, the pain is increased by pressure of any kind. The lightest touch causes the most severe distress. Infectious diseases of the nature of influenza produce this condition. In the second, the pain is increased by deep pressure only. It generally indicates some deep inflammatory lesion which is not disturbed by the superficial pressure, but is aggravated by deep pressure. For instance, in phlebitis, slight pressure over the most painful part is not resented, but deep pressure produces pain.

In the third reaction, pain is increased by superficial pressure. In this condition, Bennett believes that a vasoneurosis is present and causes a dilatation and engorgement of the vessels, especially marked in the muscles; the pain is severe and is relieved by pressure and massage. On the contrary, if the engorgement is inflammatory, and an exudate is present, the pain will be increased rather than decreased on pressure.

Tenderness may be present over the area in which pain is complained of, but which is not the area of the lesion, or it may be entirely absent over that area and be found at some distant point. A few cases of disease in which the tenderness and its relation to the location of pain differ are given below (Bennett):

DISEASE	LOCATION OF PAIN	LOCATION OF TENDERNESS
Tabes dorsalis.	Epigastrium (commonly).	Over the spinal vertebra.
Sciatica.	Often back of thigh and knee.	Over the great sciatic notch.
Intercostal neuralgia.	In epigastrium or in the middle line of the body.	Over the intercostal spaces.
Gastric ulcer.	Opposite the eighth or tenth dorsal vertebra.	Over the gastric region.
Gall-bladder disease.	In the back at the angle of the scapula.	Over the gall-bladder region.

Rigidity of the underlying muscles is, as a rule, associated with tenderness. This is a good confirmative sign that pain is present (of some diagnostic value in malingering). Points which aid in differentiating the malingerer from the actual sufferer are the changes in respiration and pulse, both in the rate and rhythm, when pain is produced. These are not absolute, because in some cases where there is actual physical objective tenderness no change in the pulse or respiration is noticed in making pressure upon the tender point or points. Changes in the pupil, however generally they occur, should also always be sought, for pain causes dilatation.

Paresthesia.—This is a term used to describe a group of symptoms simulating pain, yet not of sufficient intensity to be so classified. Under it are grouped such feelings as numbness, pricking, and tickling. They are probably due to a lesser degree of irritation than that which produces pain. For instance, pressure upon the ulnar nerve at the elbow will produce tingling and numbness, while a sharp blow will produce actual pain. Likewise, it is common when one knee is crossed over the other to have the foot of the crossed leg go to sleep from pressure on the sciatic nerve. A fractured lower end of the humerus may also press upon the ulnar nerve and cause paresthesia in the ulnar distribution.

CHAPTER V

CLASSIFICATION OF PAIN

Several different classifications of pain might be made, but the one most generally used is that which classifies them according to origin, namely, subjective and objective.

SUBJECTIVE PAINS

Subjective pains are those which have no physical cause for existence, but are a product of mental action arising from some changes of the coördinating centers of the sensorium.

There are a variety of conditions in which subjective pains play a great rôle. The most frequent of these are emotional states, hysteria, habitual reactions, depressions of various types, compulsion neuroses, etc. In hysteria, wherein, owing to intense mental concentration on the subject of pain, with the fixed idea that it can be and is present in a certain place (ovaries, for instance), it happens that, subjective to the patient, to all intents and purposes, pain is present in such an area or point. Hysterics are noted for the rapid changes in the location of their pains; for the great variety of pains with which they are afflicted, and their sudden change from those of mild character to those of great severity. These pains may have no organic basis for their presence, but may be the product of deranged mentality, the result of disordered mental equilibrium wherein impulse is misinterpreted, and the stimulus which ordinarily would be recognized as only a slight irritation is magnified, enlarged, and changed in its journey to the sensorium, so that it is felt by the centers as pain; or else the centers themselves are diseased, so that they interpret normal, non-painful phenomena as painful.

It is manifest that these ideas of pain, or the subjective impression of pain, are the result of impressions stored up in the memory centers, which are recalled when the proper associations are aroused. These recalled sensations may be either autosuggestive or heterosuggestive.

In autosuggestive sensations the suggestive stimulus arising in the organism itself is due to some pathological change, while in the heterosuggestive sensations the stimulus arises outside the organism, as in hypnosis, wherein pain can be felt in response to a suggestion made by the hypnotizer. Subjectively-excited pain can be made to appear and disappear at the will of the operator. Also, sensations which normally are pleasant may, by the suggestion of the operator, be interpreted as painful, thus showing how a functional misinterpretation may occur without any organic basis. These suggested pains often are localized in a particular organ, as in the hip joint in cases of so-called hysterical hip-joint disease. Here the area corresponds to the terminal distribution areas of several nerves, and is not localized to the area supplied by the terminal filaments of a single nerve. The projected idea of pain comes from the intellectual coördinating center acting in conjunction with the memory center. In this respect, the question has often been asked, can we conjure up in our dreams the sensation and impression of pain? From recollection of my own dreams, I am incapable of answering in the affirmative; but several of my patients have informed me that they have dreamed of being in severe pain, which proved to be a myth upon awaking, there being present no perceptive irritation which might act as a subconscious cause of the pain. This dream-pain has been described as similar to the sudden acute and agonizing pain associated with the cut of a dagger, or contact with fire, and the sensation is as real as though actually occurring. In these cases, it seems as though all the tracts from the reception center to the memory center are blocked, except those for touch and pain, and from the memory to the ideational center all the tracts except those for pain are blocked. Therefore, the ideational center perceives only impressions which by the memory center are interpreted as painful.

Emotional Pains.—The emotional pains are those which are the result of excessive emotion of any kind. They are felt in great anger, great sorrow or distress, and kindred feelings. The sensation experienced is not in reality a pain, but rather a feeling of unpleasantness. That it is an actuality may be deduced from the fact that, upon its disappearance, the body is left in the greatest fatigue. Another and a related sensation is the sense of depression felt in cardiac disease (angina pectoris). This increases to anxiety, then progresses through the stage of distress until the actual pain is apparent.

Hysteria.—Hysteria probably includes the largest number of subjective pains. It is only recently that hysteria has been recognized as an entity, and as a disease worthy of the most painstaking attention. Heretofore, when a patient complained of pain, and no objective lesion was found, he was dismissed with the diagnosis of hysteria; but this did not always prevent death from the disease with which he was suffering. The absence of a pain in a complex of symptoms where ordinarily it would be may also lead to a wrong diagnosis of hysteria. Roch mentions the case of a patient who had stercoraceous vomiting, without the presence of pain and tympany, and who was permitted to die without operation because of the diagnosis of hysteria. This case illustrates how, because of the absence of pain, hysteria might be diagnosed. The same would apply just as well if pain had been present and the other symptoms absent. That some change which accounts for the pain is present in hysteria cannot be doubted; and that the pains of hysteria are imaginary and have no basis is ridiculous. As remarked by W. H. Thompson, how is it possible for a patient, through imaginary means, to cause a paralysis of one vocal cord, when perhaps she does not even know that she has such an apparatus, or that it is connected with the formation of the voice?

Explanation of Hysterical States.—It may be of some service to glance over rapidly some of the suggestions made by various authors as to the possible explanation for these states. Clevenger (40, p. 195), for instance, believes that the anesthesia of hysteria is due to deficient nutrition from improper vascularization, the result of localized anemia from constriction of the vessels. This anesthesia is followed by a return of sensation, and in some cases by hyperesthesia or even by hyperalgesia, upon the resumption of the blood supply to the part with a consequent engorgement of the vessels. The action of suggestion in relieving pain can be explained by the lessening of the blood supply to the affected part.

Sharkey (456) points out, as an argument in favor of the central origin for anesthesia in hysteria, that when anesthesia is due to an organic disease the patient is aware of his loss, but that when it is due to hysteria he is unaware of it. This, according to Sharkey, shows that in the first case the psychical centers are intact, and that in the second case they must be involved so that the patient cannot feel pain, and at the same time is unaware of his loss.[1]

However, the most likely cause of hysteria is some disturbance of brain metabolism due to vasomotor changes. In some cases there is a transference of the hemianesthesia or hyperesthesia from one side of the body to the other. "In these subjects, the feeling on the affected side is restored when small metallic plates or compresses are applied to the skin. At the same time that the affected part recovers its sensibility the corresponding part of the opposite, healthy side or limb becomes affected. It was thought that the application of the plates produced a galvanic current and that this was instrumental in causing the transference; but it is now believed that it is due to the same thing which causes the application of cold plates to one side of a healthy person to increase the sensibility of the opposite side" (Landois, "Physiology," p. 936, American translation, 1904).

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[1] The cause of this loss may be due to the fact that the nerve cells seem to contain a substance of the nature of neurin, which can be transferred from one cell to another, in case of exhaustion of one set of cells from hyperactivity. Should the cells be unable to replenish their supply of this activating substance, they are unable to appreciate impulses, and anesthesia results. Should the activating material be in excess, the cells become irritated and respond to less than normal stimuli, giving rise to hyperesthesia and hyperalgesia. In some cases there are small areas of anesthesia or hyperesthesia over the body. These are explained by Sharkey by the fact that after the sensory fibers leave the internal capsule they separate and are distributed to widely separated areas of the cortex, so that it would be possible for some of these areas to be affected, and thus give rise to areas of changed sensibility.

Distribution of Hysterical Pain.—The area of distribution of analgesia in a hysterical subject may follow the distribution of

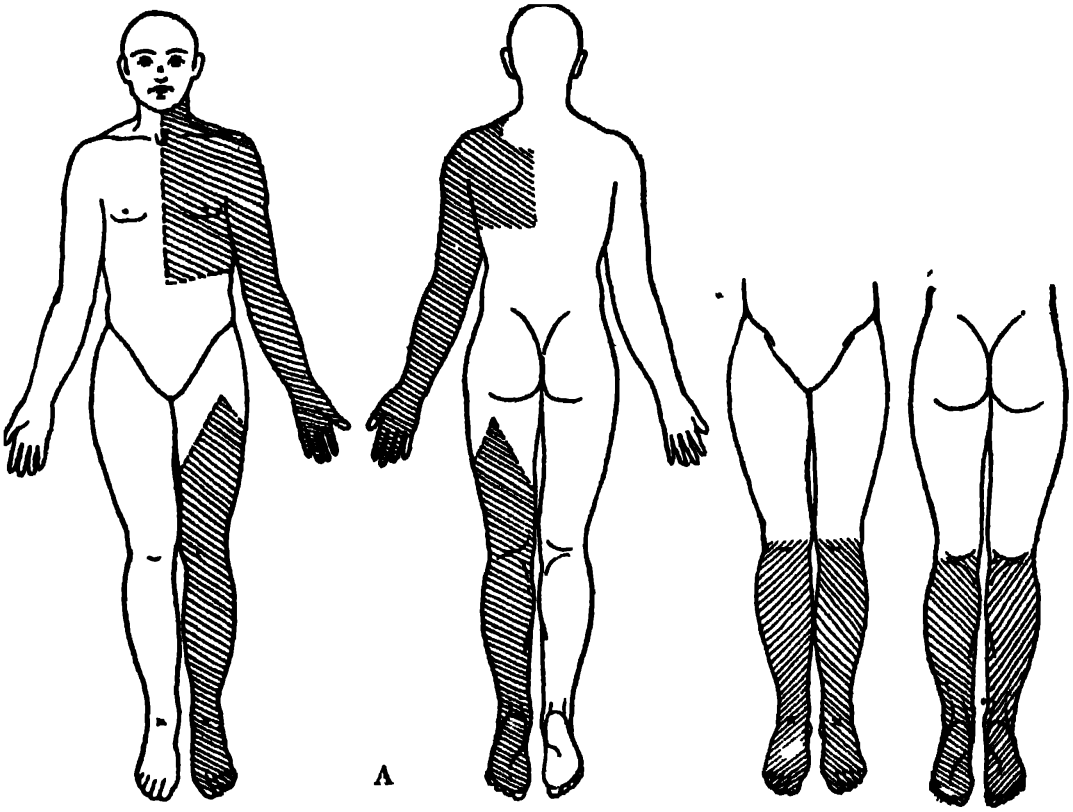

FIG. 29.—AREAS OF ANALGESIA IN HYSTERIA.
A is a case of the cerebrospinal type. B is a case of a pure cerebral type. In A all superficial reflexes to painful stimuli and to hot and cold sensation were lost over the shaded areas. Loss of sensation to touch was less extensive. In B the shaded areas indicate the loss of sensation to touch, pain, heat and cold. (From Head, Brain, Vol. XVI, p. 116.)

the cord zones, or of the cerebrospinal areas. The cerebrospinal areas generally have sharp boundaries, and have a transverse delimitation, as shown in the accompanying figures (Fig. 29, A and B), which are taken from Head. These states are independent of any nerve or nerve lesion, even section. They are not influenced by inflammation. Frequently these pains make their first appearance after the examination of the physician, who, too often, by the care with which he goes over an area, and his oft-repeated query as to the presence of sensory changes, rather suggests the pain to the patient. Hysterical pain is also frequently induced by emotional shock. Cold, heat, pressure, and irritation, as a rule, have no effect upon it. Pressure points—that is, areas which are particularly painful to pressure—are frequently found in hysteria. According to Dercum (150, p. 849), the most frequent hysterical areas are: (1) the inguinal region (women), (2) the inframammary region, (3) above the spines of the scapula, (4) to the sides of the dorsal, cervical and lumbar vertebra, (5) over the sacrum, and (6) over the coccyx.

Diagnosis of Hysterical Pain.—In the diagnosis of such a condition, the limitations of the fields of vision and the loss of the pharyngeal reflex are of considerable weight. Diller (557) classifies the evidence as negative and positive. Under the negative evidence, he cites the facts that the pain does not conform to any one organic disease, and that it is very contradictory in its character, time, appearance, and duration. Under the positive evidence is the fact that suggestion often relieves pain. The patient generally is very detailed in his description of the location, time of appearance, type, and intensity of the pain. The sufferer from real pain, on the contrary, makes but few remarks concerning his pain, and when he does so they are generally brief and to the point (Thompson). Hysterical pains are not, as a rule, relieved by drugs, such as morphin, while organic lesions are so relieved.

While in many cases a patient may seem to be complaining of a pain in order that he may arouse the sympathy of those interested, we, as examining physicians, should not conclude because we are unable to find an organic basis for the pain that it does not exist. The diagnosis of hysterical pain is often but a cloak under which the physician hides his ignorance. When we consider that the nervous system is of considerable volume and weighs about six pounds, and that it is subject to the same variations of nutrition and change as are the other tissues of the body, it is easy to appreciate how it may be subject to the vicissitudes of the other tissues, and therefore subject to irritation and fatigue, the same as are these tissues. In children, hysterical pain is very rare, because they are too young to have experienced much pain, and hence are free from pain memories, and, as a consequence, are also free from hysterical pain.

Hypnosis.—Hypnosis is sometimes capable of bringing into consciousness the stored-up pain experience of the subject. It causes those dim and forgotten sensations which have been present in the past to dawn into consciousness. It is only the drawing away of the veil from the subconscious state and the forcing of it into view. The hypnotizer can suggest the idea of pain to the hypnotized, and can make him feel pain in every act and every movement. He reproduces, as it were, the states which are present in hysteria.

Habit Pains.—A condition closely related to the foregoing is that of the so-called habit pains. This is the name given to that great class in which the pathways for pain have been so grooved from frequent repetition that on the least provocation the stimulus travels over them and gives rise to pain sensation. These frequently follow a trauma which has occurred some time previously. Such a trauma may cause abnormal or unusual susceptibility to pain production, and what otherwise would be felt as a nonpainful stimulus gives rise to pain. Habit-pains frequently persist after operations of various kinds which have been undertaken because of the pain, and continue in spite of the fact that all the abnormalities have been corrected. The persistence can only be accounted for upon the habit-pain hypothesis. The pain is particularly apt to persist when opiates, such as morphin, have been given before the operation.

Monomania Pains.—Brissaud (*Progrès Med.*, XIX, No. 2) mentions another variety of habit-pain, in which the pain recurs as a habit at a certain time, or in connection with certain objects. Brissaud believes that patients subject to such pain are suffering from an obsession, and that they have a delusion of pain when none is present. The pain resembles that due to occupation neuroses, and represents a variety of pain caused by overactivity of a certain neuromuscular apparatus, and nature's attempt to hinder excessive action.

Occupation Neuroses.—Dr. Walton ("International Clinics," Vol. IV, p. 261, 17th series) recites several cases in which, instead of the muscular spasm (found in certain neuroses, such as writer's cramp), severe pain is felt, not localized to the distribution area of any nerve, but rather extending over the area of the muscle and its insertion. This pain is induced only by making the occupation movements, and is not invariably produced even then. If the occupation is continued, every repetition of the act causes pain. By this time, the pain is produced by other movements than those of the occupation, and finally spontaneous and paroxysmal pain is apt to appear in the same region, not generally following the exact tract of any nerve, but rather distributed over the area involved in the muscular action, and perhaps radiating therefrom. Tenderness may or may not be present. Examples:

(1) Physician, laryngologist; pain in the side of the neck and back of the ear; comes on when the head is placed in the position for operating; relieved and finally cured by rest.

(2) Golf player; pain in the arm in the region of insertion of the deltoid, produced at each swing of the club.

(3) Pain in arm; persistent with paresthesia; due to sewing.

(4) Music teacher (piano); pain in right arm; numbness and easy tiring of the fingers; relieved on stopping the piano-playing.

(5) Pain in the entire forearm; due to overwork of the arm; moderate tenderness over the entire forearm present.

(6) Ticket agent; pain and tenderness on the radial side of the first phalanx of the ring finger of the right hand, due to pressure made by the corners of the tickets against the spot in stamping.

As is remarked in an editorial in the Journal of the American Medical Association (LVI, 12, 898), all of the occupation pains may be avoided by proper precautions—and as examples are given the cure of the pains in the bricklayer's back by placing the bricks on a proper platform easy to be reached, or of the hammerer who is relieved of the pains in his arm by using the opposite arm in his work.

OBJECTIVE PAIN

By objective pain is meant that pain which is excited by some cause or agent foreign or abnormal to the area in or near which it is excited. Such a pain may be produced: (1) in the centers, as the brain or cord, and (2) in the nerves, as the trunk or its terminations. It always is the result of some demonstrable pathological change.

CENTRAL OBJECTIVE PAIN

The cortical brain tissues contain no known pain-receptors. Pains in the head, about the head, etc., are due to peripheral action usually upon the receptors of the trigeminus, widely distributed in the meninges covering the cerebrum. The pain of pressure within the head, as in hydrocephalus, brain tumor, lead encephalopathies, etc., is probably also carried through the trigeminus.

Purely cortical lesions are not known to produce pain, nor are they known to bring about any increase or decrease of sensibility to measured painful stimuli Only in the case of recent lesions, or in those accompanied by epileptiform seizures, has there been found to be any reduction in pain sensibility. The cortex as a place of origin for central pains may be excluded. The rôle of the cortex in the analysis of other forms of sensibility does not lie within the province of this chapter.

Central pains, however, may be present and due to lesions in the optic thalamus, which is the chief sensory organ of the brain; the major relay station.

Two features stand out in thalamic lesions so far as sensations are concerned. One consists in the excessive response to affective stimuli. There is, as Head and Holmes express it, an "overloading of the feeling tone." It has been present in the thalamic syndrome cases reported by Roussy and others (Jelliffe, "Thalamic Syndrome," *N. Y. Med. Jour.*, 1910)., This excessive response—explosive laughter, explosive crying—bears no relation to the quantity of painful stimuli. It is an interesting feature that such variations in effective response may be unilateral.

Thalamic pains are usually very severe and intractable. They are not infrequently seen in hemiplegics who also suffer from thalamic lesions. Lesions of the thalamus seem to permit all sensory stimuli to be felt as painful. Most of the reported thalamic pains have been located in the upper extremities.

Lesions about the cord, meningeal exudates, pressures, tabes, tumor, give rise to pain. Such are, for the most part, due to action upon the peripheral sensory neuron. They are not, properly speaking, intracordal lesions, and do not, as a rule, give rise to local pain. Pain tracts may be cut off, as in syringomyelia, hematomyelia, intracordal tumors, etc., but do not give rise to pain. They cause hyperesthesia, and may lower the threshold to painful stimuli, but apparently do not cause spontaneous pain.

PERIPHERAL OBJECTIVE PAINS

Peripheral pains are those which are due to action on the axis cylinder, the ganglia cells or the receptors, and are objective in that some definite lesion (as a rule) acts as the producing factor. They may be classified as to cause, manner of propagation, time, constancy, and character.

Causes.—The causes of peripheral objective pain may be divided into *organic* and *functional*. The *organic causes* are those which are due to changes in structure, or in the relationship of different anatomical elements to each other. They may in turn be divided into *intrinsic* and *extrinsic*. The intrinsic causes give rise to parenchymatous pains, and include inflammation, new growths, muscular contraction, or displacement of parts, as in those cases where teeth have not erupted and are still in the maxilla, and where, by pressure upon the adjacent structures, they cause great pain. The extrinsic causes include all lesions making pressure upon the nerves or nerve terminals, as displacement and pressure by adjacent organs, new growths, etc., and stretching of the nerves, ligaments, or other attachments, in displacement, or in new growths of different organs.

The *functional pains* are due to excessive activity of an organ (generally the activity is transitory), as in the stomach (pyloric obstruction); in the intestines (obstruction); in the testicles (hypersexual activity); and in the brain (excessive mental work).

PARENCHYMATOUS PAIN.—Parenchymatous pain is due to some pathological condition that involves the sensory nerve terminations. It may be due to local irritation, such as occurs (1) in inflammation, (2) in torsion or stretching of the fibers by muscular contraction, (3) in thermic irritation, as in burns, and (4) in chemical changes due to acids.

(1) *Inflammatory Pain.*—An organ consists of: (1) the essential structure, such as cells; (2) the supporting structure, consisting of connective tissues, in which are found (a) lymph channels, (b) blood vessels (arteries, capillaries, and veins), and (c) nerves (sympathetic and cerebrospinal); (3) the encapsulating structures (capsules); and (4) the adjacent structures (lymph glands, nerve plexuses). Therefore, when the pain is parenchymatous, it must occur in one or more of the structures enumerated above.

In inflammation we know that the first sign of the beginning process is in the blood vessels, which dilate and thus bring an additional supply of blood to the part. It is, no doubt, the vast increase in the blood supply and the greatly increased force of the systolic impulse in the diseased area that cause the throbbing pain, recognized as the early stage of an active, inflammatory process. It is, however, very difficult to say exactly through what channels or means the knowledge of this increased blood supply is conveyed to the sensorium. It may be conveyed by the following means: (1) nerve fibers distributed to the vessel walls which are associated with the vasomotor nerves; (2) nerve fibers distributed to the cellular substance; and (3) nerve fibers distributed to the capsules of the gland.

We know that the lumina of the vessels in inflamed areas are increased much beyond their normal size, so that the combined area of the lumina of the vessels within the inflamed area is several times the area of the lumina of the vessels entering the part; and the systolic pressure is as much greater in the part as the area of the vessels in the part is greater than the area of the vessels entering it. This is according to a well-known principle of mechanics. To be more definite, we may assume the area of the lumina of the entering vessels to be one square foot, and the area of the lumina of the contained vessels to be twenty square feet. The pressure on every square foot of the enlarged area is the same as that on the small area. Therefore, it will be twenty times the smaller pressure (for example, if the smaller is one pound, the larger will be twenty pounds). Thus, it is easy to understand how the increased area of the vessels will indirectly cause the sensation of throbbing. It would, further, cause compression of any nerve fibers which are found in the organ, and would also undoubtedly exert a great pressure upon the capsule. Both of the factors would produce pain.

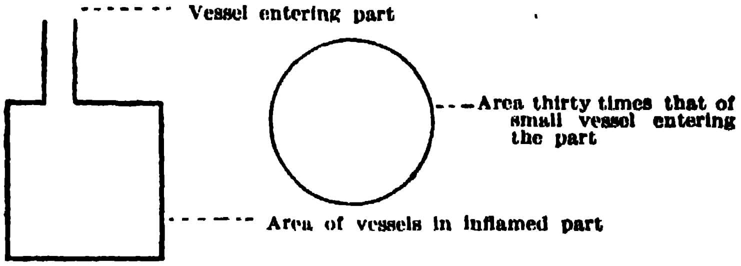
Vessel entering part
Area thirty times that of small vessel entering the part
Area of vessels in inflamed part

FIG. 30.—METHOD OF PAIN PRODUCTION IN INFLAMMATION.

The *cause* of the throbbing in severe inflammation may be the impulse of the blood in the dilated vascular paths in the inflamed area, or the result of a nervous vasomotor reflex, causing an alternating dilatation and contraction of the vessel walls. Personally, I am inclined to the belief that it is due to the propulsion of the blood into the part without any means of return, the capillary paths being blocked, and permitting but slight venous return from the inflamed area, or that the return is so slow that the blood accumulates in the part. As a consequence, the force exerted through the small vessels entering the area acts as in a hydraulic force-pump, and the pressure and force are increased in the much larger area which the vessels supply. Thus, this magnified force is seen by the alternate pallor and flushing of the part. The nerves in the part are stimulated by the dilatation of the vessels in the area adjacent to the inflammation, and impulses are sent to the cord, which sends them back again as reflexes, which act as vasomotor dilators. Thus, there is dilatation at each systole and a consequent contraction at each diastole.

In the later stages of inflammation the throbbing pain which was originally present is changed to a dull ache. This is due to the fact that, at this time, the vessel walls and the capsule are dilated to their fullest extent, and will not admit any more blood; and, instead of the intermittent, systolic pressure that is found in the early stages, there is present a pressure that is constant and unvarying. Again, as the inflammation begins to subside (provided the extravasated blood does not block the channels) the former throbbing pain may recur.

Sometimes it is found that the inflammatory reaction is not limited to the confines of the organ in which it is found, but extends beyond these limits and progresses in the course of the adjacent lymph paths, finally reaching some of the neighboring lymph glands, where the inflammatory process becomes active, thus producing further pain.

In some cases parenchymatous pain radiates in various directions from its place of origin; this radiation may be explained upon one hypothesis: that the painful impulses are conveyed from the organ to an adjacent nerve plexus where they become diffused. From the plexus the impulses are carried to the brain, and give rise to the impression that the pain arises in the entire area to which the nerves forming the plexus are distributed.

Parenchymatous pain, due to inflammation of viscera, seems to be more of a myth than an actuality, for, since it is a fact that no sensory nerves are distributed to the parenchyma of viscera, it is difficult to understand how, in the organ itself, painful sensations can be present. The following are instances (McKenzie) illustrating the absence of pain in diseases of certain viscera:

(1) Kidney inflammation, especially the chronic variety, is entirely painless.

(2) Disease (inflammatory) of the liver is without pain, as a rule, and the pain which is present in hepatitis is often due either to involvement of the capsule or to the tractions made upon the abdominal wall by the pull of adhesions passing between the liver and its parietes. The only exception is hepatitis syphilitica (Neusser).

(3) Lung tissue lacks pain-sensation, and in disease such as pneumonia the patient is entirely unaware of the baneful changes occurring in the lung until the pleura becomes involved and pain is produced.

(4) The testicle is also without pain-sensation. Yet orchitis is a condition which is very painful; but it seems that the painful reaction in this disease is due to an extension of the inflammatory process to the adjacent structures (epididymis).

(5) The heart is also without a local pain reaction. It seems that in painful cardiac diseases the painful condition is due to an inflammation of the myocardium producing pain which is referred to the anterior thoracic wall.

Characteristics of inflammatory pain are: (1) the pain is produced on pressure; (2) movement of the part affected or of any adjacent part, causing pressure on the inflamed area, causes pain; (3) the function of the part (because of pain) is abolished, as the rigidity of the hip, which occurs in hip joint disease (see Ryder, 35). It has been observed that inflammatory pain is more intense in colon-bacillus and streptococcic infection than in most other infections.

Parenchymatous pain in glandular organs, such as the lymph glands, may be due to stretching of the capsule or to involvement of the nerves which accompany the arteries into the part. In glandular tissue there does not seem to be any parenchymatous nerve supply other than these filaments which accompany the blood vessels to their ultimate divisions in the depths of the tissue. In acute infectious diseases the pain is due to irritation of the terminal nerve filaments by the toxic substances circulating in the blood. The reason for the pain being localized in a particular area is that in this area the tissues are in a state of lessened resistance and any toxic change taking place will be localized in the less resistant region.

(2) *Traction,* that is, stretching or pulling on the nerve fibers by muscular contraction, may cause pain. This is exemplified in the contractions of the stomach, intestines, gall-ducts, ureters, and uterus. It seems that the most severe pains felt by patients are those due to contraction of hollow viscera, such as the intestine gall-ducts, ureters, etc.

Torsion of the nerve fibers, such as occurs in twisting of the pedicle of an ovarian cyst, also causes severe pain.

(3 and 4) *Thermic and Chemical Irritations.*—Burns, from heat or chemical agents, cause pain by exposing the sensory terminal filament to irritation by external agents. Even exposure of these filaments to the air causes the most excruciating pain. The reason for this, in all probability, is that, because of their sudden change from a medium where temperature and surroundings are equable to a location where these conditions are not favorable, a great change in their state of irritability is produced, so that they respond to a greater degree than normal to all stimuli, and especially so to stimuli to which they had not been previously accustomed.

CHAPTER VI

CLASSIFICATION OF PAIN (*Continued*)

PERIPHERAL OBJECTIVE PAINS

Propagation of Pains.— The second part of our classification deals with propagated pains. These pains are felt in areas other than those in which they are produced. They may be divided into associated, referred, projected, reflex, and transferred pains.

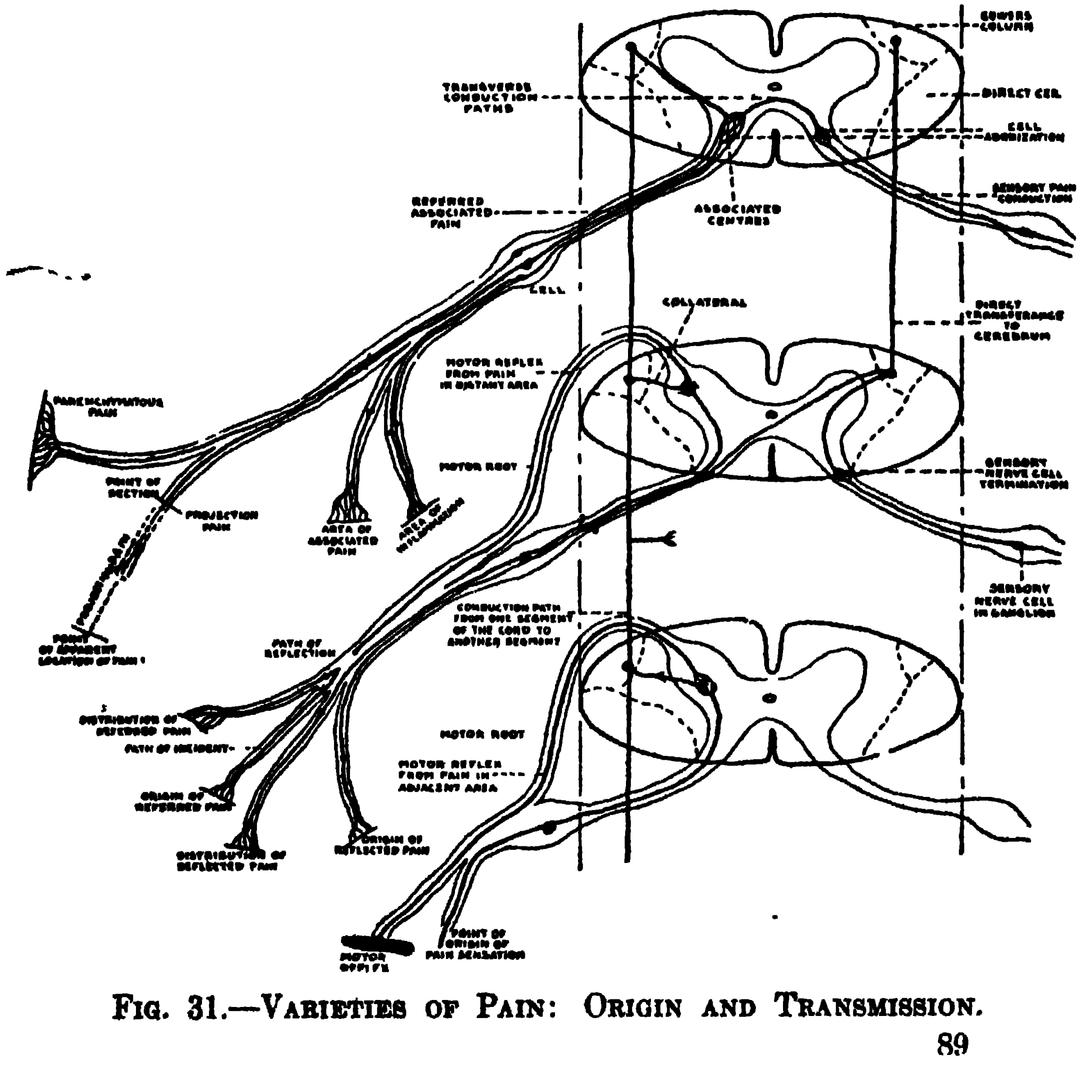
GOWERS COLUMN
TRANSVERSE CONDUCTION PATHS
DIRECT CELL
CELL ASSOCIATION
SENSORY PAIN CONDUCTION
REFERRED ASSOCIATED PAIN
ASSOCIATED CENTRES
CELL
COLLATERAL
DIRECT TRANSFERENCE TO CEREBRUM
MOTOR REFLEX FROM PAIN IN DISTANT AREA
PARENCHYMATOUS PAIN
MOTOR ROOT
SENSORY NERVE CELL TERMINATION
POINT OF SECTION
PROJECTION PAIN
AREA OF ASSOCIATED PAIN
AREA OF INFLAMMATION
SENSORY NERVE CELL IN GANGLION
CONDUCTION PATH FROM ONE SEGMENT OF THE CORD TO ANOTHER SEGMENT
POINT OF APPARENT LOCATION OF PAIN
PATH OF REFLECTION
DISTRIBUTION OF REFERRED PAIN
PATH OF INCIDENT
MOTOR ROOT
MOTOR REFLEX FROM PAIN IN ADJACENT AREA
ORIGIN OF REFERRED PAIN
DISTRIBUTION OF REFLECTED PAIN
ORIGIN OF REFLECTED PAIN
MOTOR EFFECT
POINT OF ORIGIN OF PAIN SENSATION

FIG. 31.—VARIETIES OF PAIN: ORIGIN AND TRANSMISSION.

Associated Pain.—The associated pain depends, for its production, upon the transference of stimuli from one nerve cell to another. In some cases it is impossible to tell by what means the stimuli are transferred, as in the following cases:

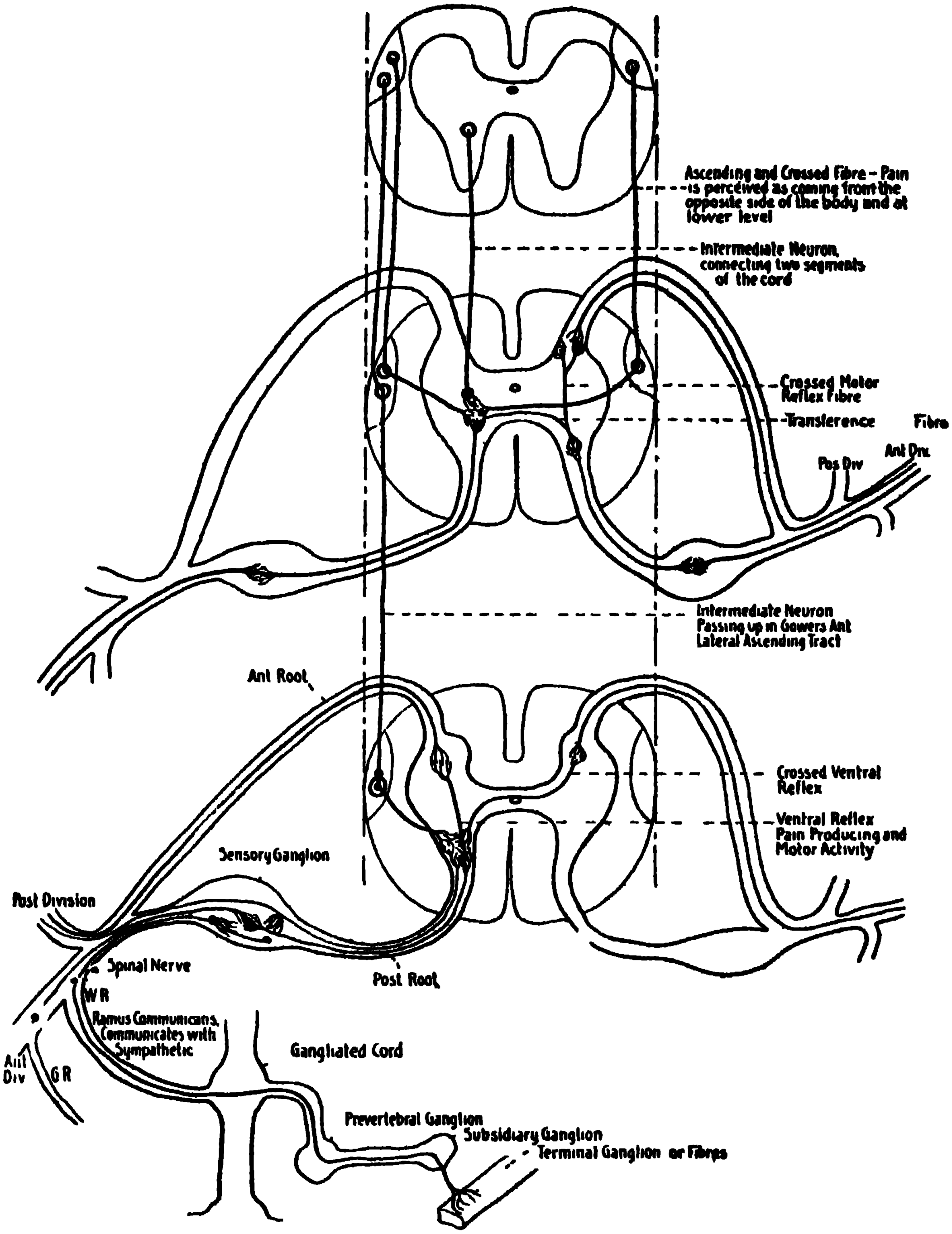
Ascending and Crossed Fibre – Pain is perceived as coming from the opposite side of the body and at lower level
Intermediate Neuron, connecting two segments of the cord
Crossed Motor Reflex Fibre
Transference Fibre
Pos Div
Ant Div
Intermediate Neuron Passing up in Gowers Ant Lateral Ascending Tract
Ant Root
Crossed Ventral Reflex
Ventral Reflex Pain Producing and Motor Activity
Sensory Ganglion
Post Division
Spinal Nerve
Post Root
W R
Ramus Communicans, Communicates with Sympathetic
Gangliated Cord
Ant Div
G R
Prevertebral Ganglion
Subsidiary Ganglion
Terminal Ganglion or Fibres

Fig. 32 Scheme Showing How the Different Varieties of Pain May Arise and How the Different Musculosensory Reflexes May Occur.

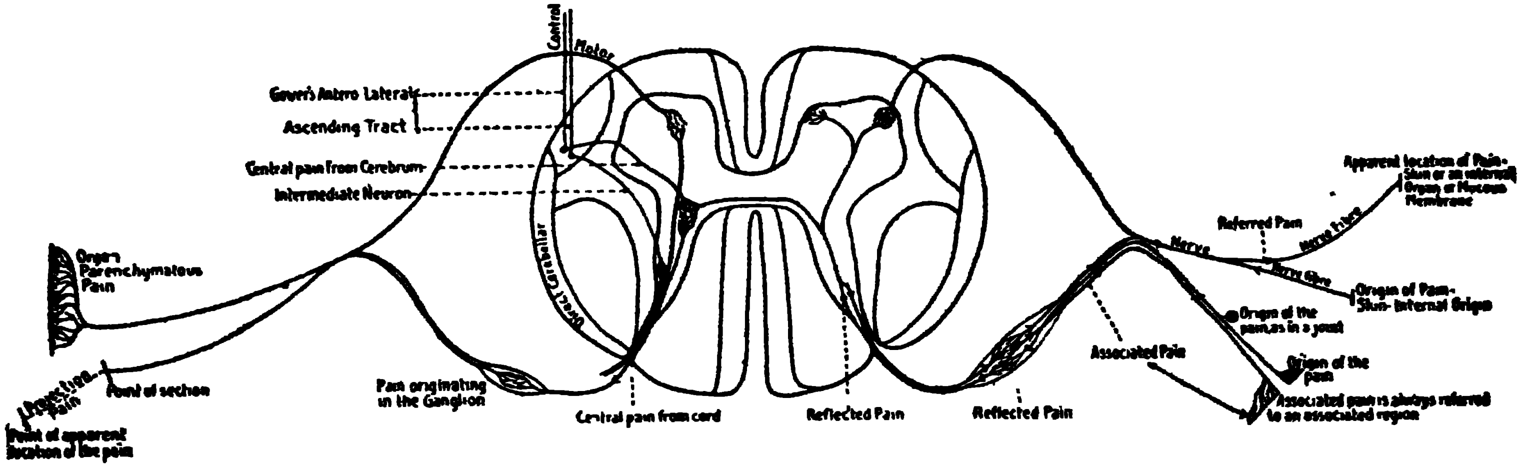
Central
Motor
Gowers Antero Lateral
Ascending Tract
Central pain from Cerebrum
Intermediate Neuron
Organ Parenchymatous Pain
Projection pain
Point of section
Point of apparent location of the pain
Pain originating in the Ganglion
Direct Cerebellar
Central pain from cord
Reflected Pain
Reflected Pain
Associated Pain
Nerve
Referred Pain
Nerve Fibre
Nerve fibre
Apparent location of Pain-Skin or an internal Organ or Mucous Membrane
Origin of Pain-Skin-Internal Organ
Origin of the pain, as in a joint
Origin of the pain
Associated pain is always referred to an associated region

FIG 33.—VARIETIES OF PAIN: ORIGIN AND TRANSMISSION.

(1) A pain in the top of the head occurred with rectal fissures. Upon the curing of the fissures, the pain disappeared.

(2) Pain under the heart, associated with labor pains. In this case there was also cutaneous tenderness, which came and went with the labor pains.

(3) Epigastric pain associated with gastritis.

(4) Pain in knee in a case of putrescent pulp of the lower second bicuspid. Upon drawing the tooth the pain was relieved. Upon sealing it again, after it had been opened and drained, the pain returned. This experiment was made several times with like results (P. V. McFarland). This pain reference is also present in those cases where two adjacent centers are involved.

If the original stimulus is very severe, and is continued long enough, adjacent centers become irritated, owing to the central stimulation by the overlapping or spilling of stimuli from the adjoining centers to which the stimulus is conveyed. This is exemplified in the ear pain which follows toothache, or in the pain in the inframaxillary branch of the fifth nerve when the stimulus is in the superior maxillary branch. In some cases the pain becomes very diffuse, and is felt over wide and scattered areas of the body. The diffusion is accounted for in two ways:

(1) By the crossing of the fibers. Some of the sensory fibers evidently pass over from one side of the cord to the other, conveying impulses which stimulate the sensory cells (in the cord) supplying the opposite half of the body.

(2) By the diffusion of the stimuli. Some of the nerve cells in the cord are in close relationship with those cells to which the stimuli from the painful parts are carried. When there is an excess of stimulus, some passes over into the neighboring cells and gives rise to painful sensations, which are interpreted as coming from the area supplied by the stimulated cells. This tendency to diffusion may be due:

(a) To reduction of the resisting power of neighboring segments, "general constitutional diseases reducing the body powers generally, and the nervous system in particular, as in anemia and pulmonary tuberculosis."

(b) Increasing excitability of the involved segment, as in fevers.

(c) Prolonging or augmenting the stimulating power unduly, as in chronic ovaritis and chronic metritis.

These diffusely distributed pains should not be mistaken as manifesting hysteria or hypochondriasis. In some cases the diffusion is so great, and the pains so general, that they are spoken of as generalized pains. (This is particularly so in the various infectious diseases.) In other cases, when a distant segment of the cord, or even the pain centers in the brain, have a reduced resisting power; or have had the pain habit, irritation in any part of the body may sensitize these centers and cause the pain to appear to come from their areas of distribution. From Fromentel's studies (Monro, 556) it appears that the relationship between the irritated point and the sympathetic point is very constant and that the sympathetic point is generally on the trunk on the same side of the body. Cases in point are:

(1) "Mrs. H., aged 44; married late in life and never was pregnant. Health has been fairly good. Several years ago she had an attack of acute otitis media, the result of chronic otitis media in the right ear. For some time the patient has suffered from dysmenorrhea, but the pain from which she suffers has been in the right ear and has been very severe. I was called to see the patient, but before I got to her house the pain had ceased. The patient visited me at my office. Bimanual vaginal examination showed an enlarged and very tender left ovary, pressure upon which caused quite severe pain in the ear" (personal communication from Dr. Torrey, Olean, New York).

(2) Pain in the chest, right side anterior, from rubbing the back of the right forearm. A touch on the back of the forearm or any part of a strip of surface extending from below the elbow to the four inner metacarpo-phalangeal articulations was felt both locally and in the area described on the anterior of the chest. Firm pressure on the part of the arm described caused no pain locally, but caused severe tearing pain in the chest front (Monro, 32, p. 9).

(3) Pain in the chest, due to pressure at the front of the wrist, at the root of the thumb, or at the flexure of the elbow on the left side. The pain caused was not local, but was felt in the left lateral region of the chest (Monro).

(4) Pain was present in the chest on the right side, over the second right costal cartilage, during each dressing of an appendiceal abscess wound.

(5) Painful stimulation of the thigh produced a pain in the back of the head (Monro, 32, from De Fromental, "Les Synalogus et les Synalgia").

(6) Mitchell quotes a case where stimulation of a mole on the leg produced pain in the chin.

(7) The headache which occurs after eating ice cream is also an illustration of this variety of pain.

(8) The headaches which occur in various diseases are also illustrative of this condition.

(9) Alger (560) reports a case of severe abdominal pain, resembling that due to appendicitis, caused by eye-strain. Upon the adjustment of glasses, the pain disappeared Three years later the patient lost his glasses, and the pain immediately returned.

In some cases the associated areas are physiologically related, as the breast and uterus (see mammary gland). It is very common for women to have pain in the breast during the period of menstruation. In many cases it occurs just prior to menstruation. This pain localization may be due to lessened resistance or increased irritability in the nerve-conducting paths, the stimulus which in one gives rise to pain, in another produces no reaction; or there may be some unusual nerve connections between these different parts, or some cryptogenic process may lie dormant in the parts and announce its presence by pain on irritation of some related part. In woman, the spinal area offers least resistance to pain at the sixth dorsal (mammary) and the tenth dorsal (ovarian) vertebra.

Misreference of pain phenomena, because of the instability of the nervous system and the imperfect development of the localizing apparatus, is very common in children. Examples of this are seen in the pain present over the appendix area in cases of pneumonia and hip-joint disease.

REFERRED PAIN.—Referred pain is the name given to that class of pain in which the irritation occurs along the course of the nerve fibers, and the pain is felt as being produced in the somatic peripheral distribution of the affected nerve or nerves. There are three places where the irritation may cause referred pain, namely:

(a) The cord.
(b) The posterior roots or ganglia.
(c) The nerve trunks or nerves.

When the irritation occurs in the cord, the pain sensation is referred along the pain paths connected with the same side of the body. When it is transferred across the cord, and is felt on the opposite side, it is called *transferred pain*. Among referred pains, due to disturbance in the cord, are the well known girdle pains, which are almost pathognomonic for tabes dorsalis, transverse myelitis, cord tumors, etc. Referred pains from lesions on the posterior roots may be due to pressure from fragments of a fractured vertebra, tumors, or inflammation, as in meningitis and herpes. The principal causes of referred pain, however, are lesions occurring somewhere on the nerve circuit. They may occur on the nerve trunk or on one of the branches (see illustration). When a lesion occurs on the trunk, it is always referred to a point on the periphery *distal* to the area at which it occurs; but if the irritation is on a branch, it may be referred to the periphery in an area *proximal* to that at which it occurred. This is due to its reference along a collateral branch. Bennett (48) gives a number of cases in which pain in the groin was due to both downward and upward reference.

The following is a table taken from Dr. Bennett's article (p. 269):

Incidents of Pain in Groin Apparently from Above	Cases
Prolapse of ovary	1
Omental umbilical hernia	1
Tumor of the pelvis	1
Stone in the bladder	1
Stone in the ureter	3
Stricture of the urethra	2
Movable kidney	1
Cyst of the testicle	2
Retained testicles	3
Intestinal diverticulum	1
Incomplete inguinal hernia	2
Traumatic lumbar hernia	1
Varicocele	3
Lateral curvature of the spine	2
Spinal abscess	1
Undetermined	2

Incidents of Pain in Groin Apparently from Below	Cases
Small omental hernia	1
Small femoral hernial sac	1
Obturator hernia	1
Saphenous varix	4
Osteoma of the tibia	1
Femoral atheroma	2
Osteoarthritis	1
Rider's sprains	4
Polypus of the rectum	2
Piles	2
Flat foot	1
Popliteal sarcoma	1
Old fractured tibia	2
Melanotic mole on the sole of the foot	1
Varicocele	2

Dr. Bennett also speaks of a case of osteoma of the tibia, in which a sharp spicule of bone sprang from the inner surface of the bone, about four inches from its lower end. Pressure upon this caused acute pains in the left groin, rather to the inner side. Pain also occurred when the limb was being flexed, as well as when it was rotated outward. Kicking also caused pain. It was due to involvement of a filament of the saphenous nerve.

Another case mentioned by Dr. Bennett is that of a pain in the knee caused by a corn. In this case, a loose semilunar cartilage was diagnosed, and the advisability of an operation was considered. The patient had sudden attacks of acute pain, most marked when he would suddenly turn around. These pains were present when he wore boots or shoes, and were entirely absent at other times.

A most peculiar case was one in which pain in the groin was caused by a mole on the foot. Pressure upon the mole, which was on the inner side of the foot, caused pain in the front of the groin. Other cases of upward reference are:

(1) Pain in the back caused by a wound of the testicle (Witmer, 527, p. 930).

(2) Pain and tender areas over the fourth and fifth spinal segments in painful disease of the breast (Treves's "Applied Anatomy," p. 176).

(3) Pain in the left clavicle in volvulus of the small intestine; condition verified by autopsy (Haworth).

(4) Pain in the back, due to a wound of the testicle (S. W. Mitchell, 559).

Cases of downward reference are:

(1) Pain in the arm and hand from pressure on the brachial plexus by a supernumerary rib.

(2) Pain in the little finger due to pressure on the ulnar nerve from a growth on the first rib (Forsyth, 126, p. 1470, quoting from Hilton).

(3) Pain in the left leg, in a case of tubercular disease of the spine, with a sinus opening in the lumbar region. Upon passing a sound into the sinus, the patient complained of severe pain shooting down the leg (St. Francis Hospital Dispensary).

(4) Pain in the hand, along the outer (radial) side, from irritation of the musculospinal nerve due to fracture of the upper part of the middle third of the humerus (Estes, 555). Estes also mentions the pain felt on the ulnar side of the hand, especially in the little finger, in cases of bone excrescences, etc., about the inner condyle of the humerus.

(5) Pain in the thigh (anterior and posterior) and in the groin, from a psoas abscess. This case I shall give in detail because of classical reference of the pain.

The patient had been sick for some weeks, and recently complained of pain in the posterior region of the leg. The point of maximum tenderness was beneath the crural fold in the crural crease. He also complained of pain in the area outlined in Fig. 34. There was a fullness present in the inguinal region, which was tender to the touch. On irritation of a narrow area of the skin next to the scrotum, a reflex contraction of the abdominal wall was noted in the area indicated in Fig. 35. This reflex was present on both sides. There was also noted rigidity of the spine, Sayre's test positive, Bryant's angle normal. When lying on the back or side, the knee was flexed and the thigh but slightly flexed; there was fullness in the left inguinal space glands, as indicated; the circumference of left thigh was 1.5 inches more than the right one. This condition gradually progressed until operation, several days later, when a large collection of pus was found in the inguinal region, which apparently came from the region of the spine. After operation, the patient quickly collapsed, his temperature became high, and he died in twenty-eight hours.

It is interesting to speculate upon the reason why pain should be felt in the area indicated. A study of the anatomy shows that the area of pain is the area of distribution of the small sciatic nerve, which was involved by the abscess cavity as it gradually crept downward into the thigh. The reflex contraction of the lower abdominal wall occurred in the area of distribution of the first lumbar segment, and the irritation which produced it was made in the area of distribution of the ilio inguinal, which is also derived from the first lumbar segment (Fig. 36). Therefore, the first lumbar segment of the cord in this instance acted but as a reflex station for the nerves which derived their origin from it. The sudden death of the patient, in this case, could only be explained by the supposition that the system was overwhelmed by toxins which were more easily absorbed when the pressure was taken away from the cavity walls on the opening of the abscess. Still, this is a rather far-fetched explanation.

Other cases of downward reference are:

(1) Pain in the epigastrium, due to disease of the spine, with a slight displacement between the sixth and seventh vertebræ. In this condition, the pain increased when the patient assumed an erect position, and, as a consequence, he walked with the body inclined forward (Hilton).

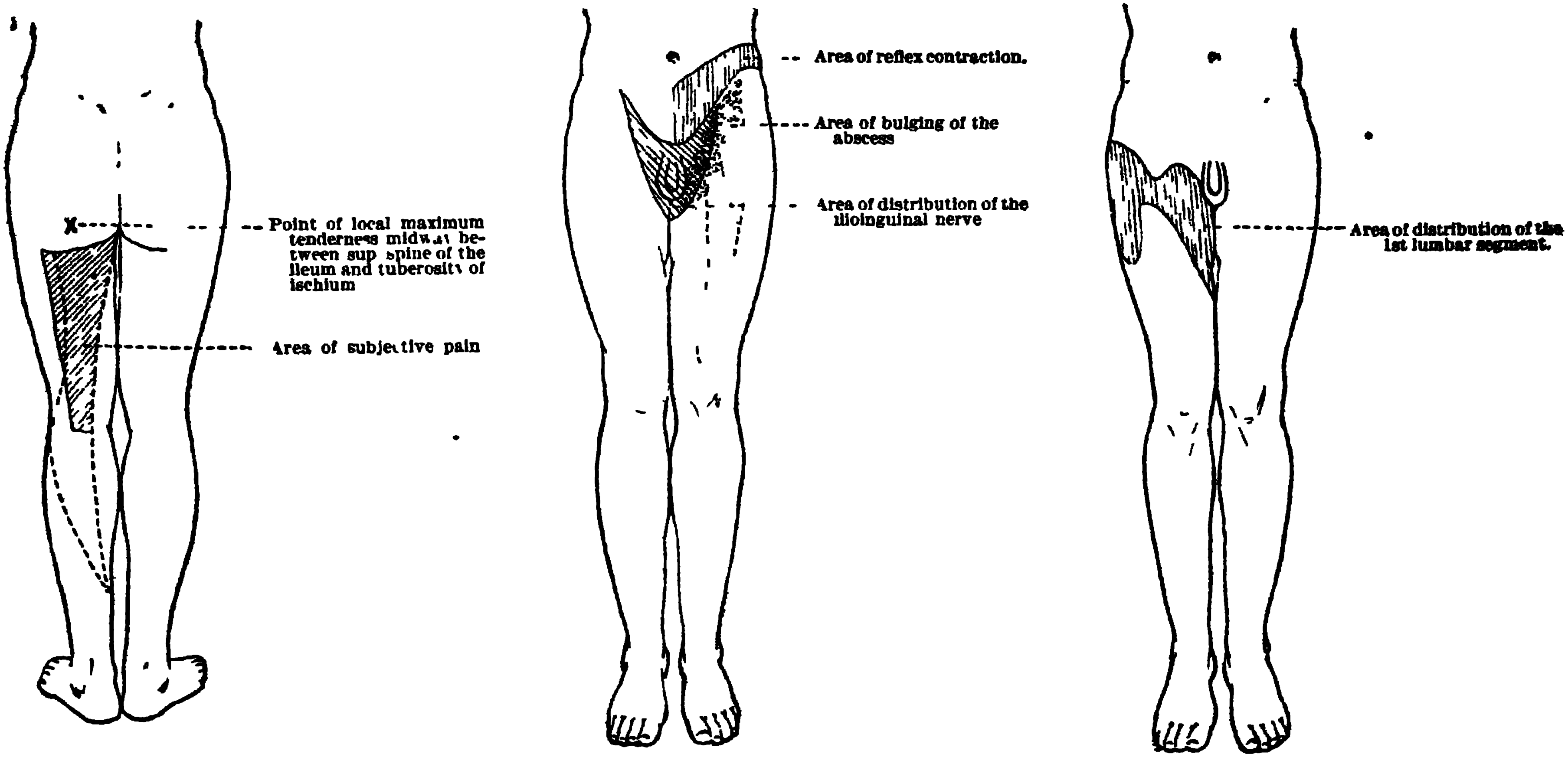
X
Point of local maximum tenderness midway between sup spine of the ileum and tuberosity of ischium
Area of subjective pain
Area of reflex contraction.
Area of bulging of the abscess
Area of distribution of the ilioinguinal nerve
Area of distribution of the 1st lumbar segment.

FIG. 34. FIG. 35 FIG. 36.

FIGS 34–36.—CASE ILLUSTRATING UPWARD REFERENCE OF PAIN.

(2) Pain in the chest, in the distribution of the fourth and fifth dorsal nerves, from an aneurysm of the aorta (Hilton).

(3) Pain in the penis from ureteral colic and from cystitis. In one case the patient, who had a stab wound one inch below the umbilicus, complained of pain in the penis each time the gauze packing, which touched the bladder, was removed. The rectum and the neck of the bladder are supplied from the second, third and fourth sacral nerves. From the same nerves the pudic nerve, supplying the penis, is derived, and thus is explained the pain in the penis, due to rectal or vesicle disorder (Monro, 32, p. 7).

(4) Pain in the great toe on the left side, in a patient suffering with perinephritic abscess, the sinus from which opened in the lumbar region a half inch from the second lumbar vertebra. Pain was noticed only when the cavity was full of solution (E. C. Stuart, personal report).

(5) Disease of the anterior third of the tongue frequently causes pain in the auditory canal, because the auditory canal, the teeth, and the anterior part of the tongue are all supplied by the fifth dorsal nerve (Monro, 32).

(6) Pain in the legs, which was very unresponsive to treatment, was found to be due to a tumor of the cauda equina.

(7) Monro (32, p. 7) also gives an example of a case of hemiplegia in which the patient, who had almost complete anesthesia of the genitals, suffered pain in the great toe every time he passed urine. This is explained by Monro as due to the common origin, from the first sacral nerves, of the nerves supplying the dorsum of the great toe and those supplying the prostate and the mucous membrane of the neck of the bladder.

(8) Pain in the calf of the leg may be present in prostatic disease (Head, "Brain," 16, p. 29).

(9) Severe earache may also be found occasionally in tonsillitis.

(10) Pain on the inner side of the ankle was due to a tumor in Scarpa's triangle.

The following are characteristics of pain due to pressure upon a nerve trunk by a tumor, enlarged and displaced organs, or other causes:

(1) The pain is continuous, and does not intermit, as in neuralgic pain.

(2) It is not increased upon pressure or movement.

(3) It does not produce muscular stiffness, differing in this respect from inflammatory pains.

(4) It may interfere with function, as in brain tumor or brain abscess. In the former there is no fever, while in the latter fever is present.

(5) It radiates very widely, especially when large trunks or plexuses of nerves are involved. A characteristic of radiating pains is that they vary greatly in intensity and location, but that they are always associated with other pains which are due directly to the lesion or radiate from it. A study of the different varieties of radiated pain will give us a clew to the focus of the disease.

(6) Tumor involving the trunk of a nerve sometimes causes trophic changes at the peripheral distribution of the nerve on the skin, in the form of an intractable ulcer, or as a herpetic eruption followed by persistent local anesthesia.

(7) Cramps in the muscles may be associated with pressure pains.

(8) A point of interest in connection with these pains is that morphin does not ease them for any considerable time, but "antipyrin, phenacetin, and other coal-tar derivatives are of considerable service, either combined with an opiate or with bromids. This is especially true in pains caused by aneurysm" (Thompson, 561).

In cases of section of nerves, J. K. Mitchell remarks that occasionally, after union of the segments has taken place, the sensations of touch and pain are referred to the wrong areas. He suggests, by way of explanation of such cases as depend upon nerve injuries, that possibly, in the union of the several nerve trunks, the axis-cylinders in the proximal part do not always succeed in joining the proper axis-cylinders in the distal portions. For instance, after a lesion of the nerves in the upper arm, nerve fibers from the proximal stump, which normally convey sensations from the elbow lesion, may unite with fibers from the distal part and with nerves which are anatomically connected with the hand. Thus, the impression due to a touch on the hand will, on reaching the seat of injury, be shunted to the path which has hitherto been that for impressions from the elbow. However, the sensorium soon learns to orient the sensations so they are referred to their proper source.

A differential diagnostic point between referred pain and neuralgia is that in referred pain no nodal points are present (J. H. Musser, 558). Apropos of this subject, and bearing upon the production of pain, Carleton (123) reports cases of referred, transferred and reflex pain, in which relief was obtained by the local application of adrenalin, either over the terminal nerve filaments or in the course of the nerve. It is difficult to understand the *modus operandi* of this relief, because it is not reasonable to suppose that adrenalin, when locally applied, can have any but a local action; and if it does have only a local action, how is it possible that it can affect the seat of production of the pain, which may be some distance away, on the same nerve or on an entirely different nerve, either on the same or on the opposite side of the body? It may be that the application of adrenalin produces some effect on the nerves, so that the transmission of painful impulses is inhibited. Carleton supposes the effect to be due to a regeneration of the nerve force, or rather the restocking of the nerve with kinetoplasm, the substance consumed in the nerve cells during their activity. How it does so is to me incomprehensible.

SYMPATHETIC PAIN.—Closely resembling transferred pain is sympathetic pain. It is really a transferred pain, with the distinction that in sympathetic pain a painful sensation is present in the organ originating the pain, while in transferred pain there may be no painful impression or sensation in the area or organ in which the pain originates. In other words, sympathetic pain is an overflow phenomenon, while transferred pain is due to conveyance of the stimulus through collateral fibers from one cord segment to another which is either adjacent to or at a distance from it. As an example of sympathetic pain, we have the pain in the axilla passing down to the arm and hand, due to angina pectoris. The axilla, arm, hand, and heart are supplied by contiguous nerve roots, the third, second, and first dorsal (McKenzie), and thus a stimulation of one segment is conveyed to the adjacent segment and the sensation is referred to the peripheral distribution of these segments.

PROJECTION PAIN.- Closely allied to referred pain is projection pain, a term given to pain which is felt as being present either in a part which has no sensation (as in locomotor ataxia), or in a part which, because of amputation, no longer exists. In the case of projection pain in an amputated limb, the pain seems to be due to the inclusion of the nerve in the cicatrix of the stump, or a neuritis, or a neuroma. It is also related in some way to the circulation. Otherwise how can the relief derived from elevation of the stump be explained? Gordon (562) enters into the psychology of the subject to a considerable degree. Every conception of a limb is due to a visualization of the peripheral stimuli which have been received. When irritation is present in the periphery of any amputated nerve, the visualization is still present, and from old association produces a picture of the absent limb. It is along this limb to the former distribution area of the various nerve fibers that the pain is referred.

Gordon illustrates the visualization of an amputated arm, in which pain finally developed, in the case of "a railroader who met with an accident twenty-seven years previous, in which his left arm was crushed and amputated. Since the operation he has always felt the presence of the left arm. Soon pain developed, which was localized, mentally, so to speak, in the left limb. The severity of the pain gradually disappeared, though the pain itself did not cease. Upon examination, the stump appears to be covered with a cicatrix. The latter is tender, and pressure upon it causes a sharp pain, which extends downward along the absent limb. The prick of a pin will also cause pain to be referred down the limb. If cold or hot water is applied to the stump, a sensation of cold or heat, respectively, will be felt by the patient down the absent limb, as far as the tips of the imaginary fingers. He also has spontaneous sensations of the absent limb, and constantly feels the presence of the arm. He feels it hanging alongside of the body; he feels the arrangement of the fingers and sometimes their movements. There is a constant unpleasant feeling, a numbness in the absent limb. He also has at times a spontaneous, sharp pain, of neuralgic character, which makes him flinch and double up. This pain, he says, runs through the ulnar side of the arm. A few months ago, the patient suffered an apoplectic seizure, following which a left hemiplegia developed. Since this cerebral disturbance, the former stump phenomenon became aggravated. The spontaneous pain in the absent arm is more frequent and intense, the numbness causes him more discomfort than previously, and finally the response to stimulation of the stump is decidedly greater."

Reflected Pain.—The next variety of pain which we shall consider under reflected (deflected) pain is that in which the stimulus is carried to the sensory ganglia or to the cord and then transferred from the sensory filaments of the neuron primarily affected to those of a secondary neuron. The stimulus is then carried, in this neuronic pathway, to the brain, and is perceived as coming from the distribution area of the second neuron. This variety of pain differs from referred pain in that in reflected pain there is a transfer of painful stimuli from one neuronic system to another, while in referred pain there is no transfer but only a misreference of the pain by the sensorium. A better term to express the true characteristic of this variety of pain would be "deflected," instead of "reflected" or "reflex." "Deflect" means to turn aside, or to shunt, while "reflex" means to turn back; and, since the pain is not turned back, but is only swerved into another pathway, it seems that "deflection" would characterize the change more than would "reflection." Besides, in physiology "reflection" is generally used to indicate a reaction produced in some portion of the body by a change in another part; and for this reaction "afferent and efferent fibers are necessary. The former are of a necessity sensory; the latter may be motor, vasomotor, vasoinhibitory, cardioinhibitory, or secretory. They are never sensory, for the simple reason that a sensory nerve is always afferent, and there can be no reflection without descending fibers" (Hart, 273, p. 344), so that it would seem to be better to use deflection instead of reflection. These deflections probably have an anatomical basis. Recent researches show that the nerve cells (in a segment) of the cord undergo degeneration as a result of any lesion in the corresponding segmental distribution area (Lickley, 138, p. 438). This confirms the hypothesis that stimuli causing pain arise from direct irritation from pathological changes in the cord, and are not due simply to a transfer of stimuli from one set of cells to another.

The most numerous and important of reflected (deflected) pains are those due to pathological changes in the internal viscera. The viscera of themselves have no sensation of pain, as elicited by ordinary pain-producing stimuli. They can be cut, torn and sutured without the production of pain; likewise, they are insensitive to heat and cold, but have a sense of their own which tells the sensorium of their well-being with a sensation akin to that which we term muscle-sense, or joint-sense. When the viscera are irritated, the stimuli are carried to the cord and react on the cord cells; and impulses are produced and sent out as motor impulses, or are carried to the brain by the neurons of these cells, where they are perceived as painful. At the same time, the adjacent set of cells become irritable, and react abnormally to all stimuli reaching them from the periphery. Thus, we have the origin of the hyperalgesic zones of Head. These zones are not always present over the area of the involved viscera, and the reason for this, as given by McKenzie, is that in the course of development the tissues, which in a low form of life must immediately have covered the organ, became displaced. In this way, several peculiarities of pain-production may be explained. For instance, the pain in the testicle in ureteral colic is felt, because, in early fetal life, the testicle was very high in the abdomen, and was supplied by the first lumbar segment. Then it began to journey through the abdominal ring and into the scrotum; but it always retained its nerve supply. The ureter, likewise, receives its nerve supply from the same segment, so that when irritation occurs in the ureter the pain is often referred to, and is felt as arising in the testicle, which at the same time is tender. In renal colic the skin of the scrotum is never hyperalgesic, because the scrotum is supplied by the sacral nerves; but the deep coverings of the testicle are always hyperalgesic, because they are in relation with the same cord segment as the kidney (McKenzie).

The method of localizing the viscus causing the reflected pain is given below:

(1) Determine if, in connection with it, there is an associated area of hyperalgesia.
(2) Delimit the area of hyperalgesia as nearly as possible, and orient it with a cord segment.
(3) Find out what organs are supplied by this segment.
(4) Examine the organ or organs for disease.
(5) See if the pain can be reproduced by manipulation of the organ.

The general lowering of the vitality of a patient often aids in the production of reflected pains by reducing the resistance and increasing the irritability of the affected cord segment.[1]

Sometimes reflected, referred, or transferred pains are confused with neuralgia; from this they can be differentiated by the injection of cocain, which will ease the pain of a neuralgia, but will have no effect on referred pain.

TRANSFERRED PAIN.—Transferred pain is the name given to that variety in which the stimulus passes from the neuron in which it is originally present, over an intermediate neuron, to a third neuron, in the area of distribution of which it is perceived as being present.

In other cases the sensorium may mistake the peripheral distribution of the pain, as in degeneration of the posterior roots (tabes), or of the ganglia and posterior columns, or cornu of the cord. It is very likely that in certain conditions the sensory impulses which are carried by the sensory fibers and the gray matter are not entirely obtunded or destroyed by the pathologic processes which have taken place, so that touch can be conveyed to a minor degree, and localizing sensations, such as those which tell us of the position of a limb, may be present only in a very restrictive sense. Therefore, an impulse propagated through the sensory pathways is very weak, and on its perception by the brain (there being little or no localizing stimulus accompanying it), is perceived as coming from the opposite side where the localizing neurons are intact.

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[1] For a more complete exposition of this subject, see under Head's Zones, Visceral Sensibility.

When the transference occurs in the cord, the segment affected may be homologous to the segment in whose area the impulse was originally received, or it may be higher, or it may be lower. In the latter cases the impulse is transmitted to the perceptive (third) neuron through some of the collateral branches.

Examples of pain transferred to a homologous segment in the same relative position on the opposite side of the abdomen are found in appendiceal and ovarian diseases, pneumonia, and pleurisy. Examples of higher and lower reference are found in those cases in which the pain of pneumonia is transferred to the appendiceal region, or in which the appendix causes pain which is transferred to the thorax. Mitchell (559) cites two instances of this variety of pain. In the first case a window fell on a finger upon which there was a felon. The pain was felt in the finger, and at the same time in the face and neck on the opposite side of the body. The second case is that of a patient who had a heavy weight fall upon his right foot, striking the toes. The great toe and the one next to it were injured. Immediately pain was felt on the antero-internal aspect of the opposite leg, at the junction of the upper and middle thirds. The pain was of a burning character, fairly constant, and worse at night. It persisted for three weeks longer than the pain in the injured part. The case has also been cited of pain in the left thumb caused by a felon on the right thumb. In another instance a wound on the right side of the neck caused paralysis and pain in the left arm (Mitchell, 559). Mitchell also mentions a case in which a shell wound in the right leg caused the patient to complain of a burning pain in both the left and the right arm and in the right pectoral region.

In regard to the cause for the persistence of these pains, I shall quote from Dr. Mitchell (559), who says that "one can, in a measure, comprehend that a violent stimulus to a sensory nerve can be switched off on to other nerve tracks or centers, as if it were the escape of an overcharge; but even if we hazard such a hypothesis, it is still difficult to explain the persistency of these transferred impressions, for it is a law of the receiving centers for painful impressions that when the cause of the pain ceases to be active the feeling of being hurt ends. But in some of these examples of false reference of pain there must have been made in the center some more or less permanent change that continuously represents the effect to which any pain-producing agency usually gives rise."

I have noticed that pain is more likely to be referred to the opposite side from that on which the lesion is located, in elderly, unmarried females. What, if any, bearing their social state has upon this fact I am unable to say.

Character of the Pain.—Another classification of pain is that founded upon the description furnished by the patient. This is most varied. A patient with a lively imagination can, of course, give a more vivid description of pain than those of a somewhat duller mentality. Naturally, the pain is likened to some sensation which has been experienced in the past; hence the terms: burning, gnawing, cutting, pinching, smarting, lancinating, boring, shooting, screwing, gripping, stabbing, grinding, sharp, dull, aching, lightning, tearing, creeping, throbbing.

In earlier times this method, founded on the description of the patient, was the one usually employed; and, with the tendency of the age to scholasticism, pains were elaborated and defined until a celebrated physician of the time of Trajan recognized thirteen varieties, and, not to be outdone, Halmeman, another early physician, distinguished seventy-five. Avicenna, in the tenth century, A. D., wrote a work on medicine, in which, among other matters, he distinguished fifteen varieties of pain (Allen, 563).

This method of classification, however, proves very unreliable, because of the difference in susceptibility of different people, and of their varied powers of expression. Yet, it is of some value in diagnosis, for certain pains, as described by the patient, are characteristic of certain disease (Church and Peterson, p. 960), as the lightning pain in tabes, the gnawing pain in rheumatism, the burning pain in neuritis, the girdle pain in spinal disease, the lead-cap pressure pain in neurasthenia, the sharp, cutting pain in neuralgia, and the dull, aching pain in infectious diseases.

Persistency of Pain.—Pain is divided, according to persistency, into *constant, intermittent* and *remittent.* Each of these may again be divided, according to the subjective feeling, into dull, aching, etc. Likewise each may be classed under some variety of the anatomical divisions of pain, as referred or reflected. When a pain is constant, it is necessary to investigate those conditions which act constantly and which produce pain. Among the most common causes of constant pain are new growths pressing upon the nerve fibers somewhere in their course. This pain is referred to the peripheral distribution of the affected fibers. Should the pressure be produced by an inflammatory mass, the pain is constant, but is marked by periods of lessened severity. These periods indicate the intervals in which the inflammatory congestion is diminished. In other cases the remission may be complete, and the patient may be free for a shorter or longer interval, as happens in salpingitis and oöphoritis, in which frequently the pain is absent during the intermenstrual periods, and reappears when the menstrual congestion occurs and the blood pressure and internal congestion in the affected organs are again increased.

Under certain conditions, pain may occur in paroxysmal attacks of great severity, to which the term *crises* has been given. According to Fenwick, who quotes from H. C. Moore, a pain crisis consists of a paroxysm of pain as violent as human nature can endure, accompanied by excessive functional activity of the part attacked, but disappearing as rapidly as it appeared, and is associated with a condition of undisturbed functional activity of the affected viscera between the paroxysms (Fenwick, 569).

Time of the Pain.—Pain may be further divided into *diurnal* and *nocturnal.* Diurnal pains are worse in all those conditions which are aggravated by activity, either mental or physical. For this reason neurasthenics and those afflicted with diseases of the locomotor apparatus suffer more during the daytime. Such conditions are found in rheumatism, neuralgias (as sciatica), flat foot, joint disease, etc. Pain is also greater during the day in eye-strain and diseases of the eye, and also, as a rule, in diseases of the gastrointestinal tract. This is due, in both cases, to the fact that during this time the organs are most active. Yet, as a rule, it seems that nocturnal pain is more frequent than diurnal pain. When pain is present during both periods, it is more severe at night, because during the day the mind has so many other affairs to occupy its attention that it does not perceive the pain sensations as acutely as it would if it were free of other impressions. At night everything is quiet, the other senses are in abeyance, and the pain-sensation enters and alone occupies the mentality.

Among pains which are prominent at night are those due to syphilis, uremia and gout. Schmidt (564, p. 68), in speaking of these conditions, says: "It seems that, as a result of the diminution of the metabolic function, through the absence of muscular work, there is a decrease in respiratory and cutaneous activity. Therefore, when a dyscrasia exists, the toxic curve ascends at night and leads to nocturnal attacks of pain. The pain of tuberculous hip-disease is also most pronounced during the night. In this disease when night comes on and the patient is asleep he often cries aloud and awakens complaining bitterly of the pain in his hip. It is claimed that the pain is due to a relaxation followed by a sudden contraction of the muscles around the joint. During the day they are contracted and hold the limb in such a position that the least possible injury can be done to it. During the night these muscles relax and the limb falls away until slight pain results. Then the muscles sharply contract and draw it again to the position of least pain; but as they do so, they also throw the head of the bone forcibly into contact with the acetabulum, and thus cause the sudden, sharp, acute pain, of which the patient so complains."

Colics are also most pronounced during the night. Schmidt (564, p. 64) says: "It seems that a relationship exists between smooth muscle fibers and striped ones, so that when one set is active the other is idle. During the day the striped muscle fibers are active, and, as a consequence, the smooth ones are idle, while the smooth ones become active during the night, when the striped ones are idle."

Gall-stone and appendicitis pains are frequently present at night, many hours after the ingestion of food. (For fuller discussion, see Gall Stones and Appendix.)

When a patient gives a history of pain occurring at particular times one should inquire as to his habits of life, what his routine of work is, how and when he eats, and if the pain seems to be associated with the ingestion of food. If it does, one should ascertain if it follows the ingestion of all varieties of food, or only certain varieties, and inquire whether the pain is relieved by the ingestion of food. Hunger headaches and hyperacidity pains in the stomach areas and pains of duodenal ulcer are eased by the taking of food, particularly albuminous foods.

In some cases the pain-sensation travels more slowly than is normal, the so-called delayed pain. In these the touch-sensation is present some time previous to the pain-perception. Tabes dorsalis gives such a pain-reaction. It may be observed by pricking the patient with a pin and having him say "Now" when he perceives the sensation of touch, and "Oh" when the sensation is painful. He will say "Now" much earlier than "Oh," showing that the pain-perception is delayed. It is hardly possible that the delay occurs in the transmission, for it seems that all impulses travel along the nerve with equal speed; yet, such is the explanation given by Landois ("Physiology," p. 936, American translation, 1904).

Sensitiveness to Pain.—It seems that sensibility to painful impressions is present in early infancy, but is not as acute as in later life. The infant, at the time of its birth, I have no doubt, is able to receive the impressions which later it interprets as painful; but it requires time to learn to coördinate the sensory impressions and classify them as beneficent or harmful, so that at this early age pain-perception has not as yet entered into its consciousness. We may say that the infant has an instinctive dread of all sensations which betoken an act or condition detrimental to its welfare. This protective and defensive instinct is an inherent and non-cognitive factor in its development, arising not from previous experiences, but from some inherited and latent consciousness which awakes under the stimulus of external life and takes upon itself the defense of the organism through the perception of all pernicious impulses as disagreeable sensations (principally as pain) from which it is wise to be dissociated. As the infant develops, it becomes more sensitive to all painful impressions until, in adult life, it probably has reached the acme of sensitiveness. From this period until middle age the perceptive powers probably are stationary. Then, as age advances, they again become reduced, until in old age they are once again at a minimum. As the ability to withstand pain differs at different ages, it also differs among races and individuals of the same race. Among races, it is claimed that the Hebrew stands pain less easily than any other race (Editorial, *British Medical Journal,* April 14, 1906, p. 880). Such general statements, however, smack of the feuilletonist and are not to be taken too seriously.

Individual Susceptibility.—Among individuals, the ability to withstand pain varies markedly. It seems that those of a fair and very delicate skin are most susceptible. In these people the pain-receptors, because of the lack of protection which is given by a thick epidermis, are more exposed and possibly more subject to irritation than in those of a thicker integument. Such people are not only very susceptible to pain, but also to cutaneous irritability of any kind. Others, because of lack of mental development, are incapable of acute perception of pain; while still others, because of intense will power, or of some inherent inability to perceive pain, are comparatively immune. Bennett mentions such a case of stoical disregard for pain. A celebrated French surgeon was performing an amputation, and, seeing the look of distress on the face of the patient, said: "I fear I am causing you great pain," to which the patient replied: "No, the pain is nothing; but the noise of the saw sets my teeth on edge."

Ottolenghi (449), who made records of cases of six hundred and eighty-two women, found that women were less sensitive than men, and draws the following conclusions in regard to pain in women at different ages. He states that the sensitiveness is less in early life, increases to the twenty-fourth year, and then decreases. This sensitiveness is greatest in the nineteenth year. The higher the type, the greater the sensibility. The left temple and left hand are more sensitive than the right. Luxury seems to increase susceptibility to pain-perception. The divisions of womanhood, in order of susceptibility to pain, are: (1) girls of wealthy classes; (2) self-educated women; (3) business women; (4) university women; and (5) washerwomen. We have here a generalization which must be taken "cum grano salis."

Tissue Susceptibility.—Tissues vary in susceptibility to pain. Metzinger (328, p. 141) claims that the blood supply of an organ often determines its sensitiveness to pain, as the organs which are the richest in blood supply generally suffer the greatest pain, and that organs poor in blood supply have little, if any, pain. This is in accordance with the theory of Oppenheimer, who claims that the pain is created and carried by the vasomotor system. As examples of the effect of blood supply, he cites the lack of pain in cartilage, nails, and hair, and the slight pain in pneumonia, while pain is present to an enormous degree in the periosteum, perimysium, pleura, peritoneum, etc. He gives bone as an example of a tissue which is free from pain,[1] but he says that this is due to the fact that when blood-vessels enter the compact structure of the bone they discard their muscular coat and so lose the vasomotor nerves and the pain sense. These sympathetic vasomotor fibers are supposed to issue by the post root, with the sensory fibers, and enter the spinal ganglia. In the cord they can be traced to the antero-lateral ascending tract. Some fibers pass to the anterior horn, and still others to higher or lower ganglion cells.

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[1] In recent experiments we have found that the medullary cavity of bone is very sensitive.

CHAPTER VII

THE INTENSITY OF PAIN

It is always interesting, and in some cases it is important for the diagnosis, to know the intensity of the pain suffered by the patient. The patient should always be interrogated, therefore, regarding this point. Very often the answer is of considerable importance in enabling the clinician to make a diagnosis; but when the physician takes the word of the patient he is apt to be misled, perhaps not intentionally, yet misled, nevertheless, because in the great anxiety of the patient to give a proper importance to his complaints, he is apt to magnify his symptoms. However, there are certain means of checking the patient's statements so that it may be ascertained whether or not he is speaking the truth.

FACTORS UPON WHICH INTENSITY DEPENDS

Before going into details concerning these means, we must first study the factors upon which the intensity of pain depends. These factors are: (1) the stimulus; (2) the sensitiveness of the patient; (3) the irritability of the nerves; and (4) the extent and number of the nerves involved.

The Stimulus.—The stimuli may be of different degrees and strength, and they may be exerted continuously or intermittently. A stimulus that is exerted continuously will be felt, at first, as much more severe than one of equal force which is not so exerted. As the stimulus continues, the reaction becomes weaker, until the perception center is dulled and does not react at all. Likewise, a constant stimulus alternately weak and strong will be more painful than one which is constant, but of equal force. The reason for this is that when the stimulus is constant, either the conducting or the perceptive apparatus becomes fatigued, and the stimulus is not perceived as acutely as when intermissions take place, since during these intermissions the nerves have time to recover their sensitiveness.

Sensitiveness of the Patient. Susceptibility to pain varies among different individuals. Some react to a painful stimulus much more readily than do others. My experience has shown that those of a thin and neurotic build suffer much more severely than do the heavier and more robust There seems, also, to be a certain relationship between the degree of mentality and susceptibility to pain. The higher the development and the more vivid the imagination, the greater is the susceptibility. Those who are not particularly affected by pain or emotion we call phlegmatic. All their sensibilities seem dulled and inactive.

Irritability of the Nerves.- The trigeminus, the sciatic, and, it is said, the splanchnic nerves are, as compared with others, extremely irritable.

Extent and Number of Nerve Fibers Involved. - The severity of the pain depends upon the number of fibers which are involved. The greater the number of fibers the more intense the pain.

FACTORS MODIFYING PAIN PRODUCTION

The factors modifying pain production are psychical and physical.

Psychical Factors. —The psychical factors may be divided again into emotion, consciousness, suggestion, diversion of attention, and expectation of pain.

Emotions greatly modify pain sensation. For instance, violent anger or great joy preëmpts the sensorium to such an extent that sense-perception is dulled and may become absolutely negative. *Consciousness,* of course, is necessary for the perception of pain, and the more acute the consciousness the greater the pain. Those who are worn out with physical work will often suffer less from an injury than their more vigorous fellow-workers. *Suggestion* is also of considerable importance in pain phenomena. Many modern cults have made capital out of the fact that pain may often be eased by concentration upon some other object, or by self-persuasion (auto-suggestion) that pain is not present. Yet this is not new, for physicians have made use of this principle even as far back as the time of Pharaoh. *Diversion of attention* is important, for the reason that when a patient's attention is drawn to some object, and is entirely engrossed with it, he has two centers (sensory) which are active, as a consequence of which neither is apt to be as sensitive as if acting alone.

Physical Factors.- Physical factors influencing pain may be divided into the *intrinsic* and the *extrinsic*. Among the intrinsic factors are digestion, motion, urination, defecation, menstruation, respiration, and position of the body. Among the extrinsic factors are pressure, heat, cold, electricity, and drugs.

INTRINSIC.- *Digestion*, as a rule, causes pain only when disease of the alimentary tract or some of its related organs is present. The severity of the pain depends upon the kind of food taken, and the variety of the lesion. In all cases indigestible food increases the pain. When the pain comes on immediately after eating, one would naturally think of gastric ulcer; if in an hour or two, of duodenal ulcer; and if in three or four hours, of gall-bladder or common duct disease. Also, at about the same interval pain due to appendiceal or colonic diseases makes its appearance, although that from colonic disease generally occurs somewhat later, say in five or six hours. Should the entrance of food into the stomach ease the pain, carcinoma, duodenal ulcer, or a pure neurosis is probably present (Schmidt). Should the pain come on during the ingestion of food, it indicates some disturbance in the esophagus, such as ulcer, stenosis, or a lesion at the cardiac entrance to the stomach, such as cardiospasm.

In all inflammatory states, when *motion* causes pressure to be made upon the inflamed area, pain results. When a patient complains of pain upon moving a part, careful investigation should be made of the muscles, bones, joints, and nerves composing that part. In connection with the muscles the most common painful affections are inflammations, as myelitis or abscesses. In some cases, while the lesion is not in the muscle itself, it is adjacent thereto, and contraction of the muscle will produce traction and pressure upon the inflamed area. Such a condition is found frequently in appendicitis. The appendix lies over and is joined to the psoas, so that each time the limb is flexed, and the psoas contracted, pulling and traction on the inflamed tissues occur, and pain is felt. Therefore, whenever pain is complained of in connection with muscular movement, not only the muscle but all of its adjacent and related structures should be investigated. Should the muscle prove negative the bone may give some information as to the cause of the pain. In this direction the first line of inquiry will be as to the condition of the periosteum, and if it is found to be healthy, the bone may be excluded as a cause of the pain. After careful investigation of these structures, the joints should be examined, and flexion and extension tried. Especially in disease of the articular cartilages pressure made by forcibly pressing the two articular surfaces against each other is provocative of the greatest pain.

Pain may be caused by *change of position*. This occurs especially in those organs which are held in position by "ligaments and end attachments, such as the stomach." Here a change of position produces a disturbance of their relationship to surrounding organs, and in some cases a derangement of their functional economy. It may produce, also, pressure or traction on an inflamed area. All of these factors lead to an increased amount of irritation and pain. The occurrence of a painful lesion upon a change of position of the patient indicates a local disorder. Certain positions are characteristic of certain classes of disease (see Positions of Pain).

Pain associated with *defecation* occurs at the time of the movement, or a little later. If it occurs at the time of the movement one would naturally think of some lesion involving the sphincter or the anus. Of these, inflammation, from simple infiltration to abscess formation, is very painful. As much so, or even more painful, is fissure or ulcer of the anus. When the pain persists for some time after defecation an abscess may be present. Pain coming on immediately before the act indicates deep-seated ulceration, such as would occur in carcinoma of the rectum (Schmidt, p. 42). Abdominal pain, the result of straining accompanying bowel movement, may indicate some quiescent inflammatory process in the appendix or the gall-bladder. By constipation the pain of enteroptosis, intestinal atony and neuropathic conditions is retarded.

EXTRINSIC.—Of the extrinsic physical factors modifying pain, *pressure* is by far the most important. In many instances it is the underlying factor of pain-production. Structures are so joined and related to each other that pressure is constantly exerted by the one upon the other, and any disarrangement of this adjustment may cause the pressure to become excessive, and result in pain.

Electricity causes pain by stimulating the pain receptors. The pain may also be due in part to muscular contraction and to sudden changes in the relationships of the parts, caused by opening or closing of the circuit. The faradic current is probably the most painful. The static spark is also quite painful.

Extremes of *heat* and *cold* both cause pain, and, most peculiarly, the sensations caused by excessive degrees of either are almost identical. Thus it is that one speaks of the burn due to excessive cold. In case of pain due to freezing of a part additional pain is produced by placing the hand in hot water, which is due to the dilatation of the vessels and engorgement of the tissues of the part. This engorgement increases the pressure upon the pressure-pain receptors, and thus causes an increase of pain. Cold acts in an opposite manner. It causes contraction of the vessels and a lessened blood supply in the part. Metabolism is interfered with, and toxic products[1] accumulate in the tissues. These act upon the sensory receptors in the part and cause pain in addition to that caused by the action of cold upon the cold pain receptors. In either of these cases the pain is due to the stimulation of the temperature receptors, plus the stimulation of the deep sensibility receptors. In some cases of heat pain, for a short time two different sensations are felt, one being that of heat, and the other that of pain. Then the sensation of heat disappears and only that of pain persists. The only reason that both cannot continue is that the pain sensation soon becomes paramount, and preëmpts the sensorium. Another argument in favor of the separate origin of temperature sensation and of pain sensation from excessive degrees of heat or cold is that pain may be present from hyperstimulation of either, in the absence of temperature sense. That is, excessive degrees of heat or cold produce pain, while moderate degrees of either cannot be recognized, or, if they are, the one is confused with the other.

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[1] Toxic products also in some cases produce anesthesia. See under Toxemia.

Drugs modify pain by various means. They usually block the carrying power of the nerves peripherally (morphin or cocain) or centrally (morphin or ether). They may create changes in the organs in which pain arises, and thus cause changes in the pain. For instance, alkalies reduce the acidity of the stomach and decrease the pain caused by a hyperacidity. Mercury and the iodids frequently relieve pain due to syphilis. On the other hand, tuberculin increases the pain, if it is due to tuberculosis (Schmidt, p. 40). Emptying the bowels relieves certain headaches. The withdrawal of morphin, in the case of a person who is accustomed to its use, very frequently causes great pain.

Weather.—Pain also seems to be influenced by temperature changes, for it has been observed that a lessened barometric pressure causes a weakened resistance to pain. Evertt (566), from a study of a number of cases, found the period of greatest pain to be from nine to eleven A. M. A period of less severe suffering is between eight and ten A. M. Barometric changes influence the production of pain much more than does the actual presence of storms. Damp, musty weather also influences pain production (Head and Rivers, 201, p. 54). Evertt believes that the cause of this increase in pain is that the electricity in the air, is increased during these periods of atmospheric unrest.

ESTIMATION OF THE INTENSITY OF PAIN

It is necessary, not only to know that a person has pain, but also how to estimate and measure its intensity. This knowledge is important in order to check the many misunderstandings that occur, sometimes intentionally, sometimes unconsciously, between the physician and his patient. It is also of value occasionally, in deciding upon the progress of a disease. The different means of measuring the intensity of pain are: (1) blood-pressure elevation; (2) motor reflexes; (3) complaints of the patient, compared with his ability to withstand pain; (4) reflex vasomotor signs, as syncope; (5) dilatation of the pupil; (6) amount of morphin necessary to overcome the pain; (7) appearance of the patient; (8) patient's description of the pain, and (9) mechanical factors.

Blood-pressure Elevation.—Blood-pressure elevation is an important means of estimating the intensity of a pain. Studies along this line have been made, particularly in Germany, where the question of simulation is so important, because of industrial insurance. Curschman (567) found that in eighteen out of twenty people with normal sensibility the blood pressure rose eight or ten mm. of mercury under stimulation with a faradic current (on the upper part of the thigh). In the other two persons the rise was somewhat higher (ten to fifteen mm.). In nine cases of hysteria and in five cases of disease of the spinal cord, the pressure was unaffected. During the gastric and intestinal crises of tabes, and in lead colic, a pressure of 170 to 210 is common, but quickly subsides to normal, 115 or 120 mm., when the attack is over. In other painful abdominal affections only a very moderate increase in pressure, ten mm., occurred. Janeway reports the following cases: (1) A woman of twenty-eight, with a blood pressure of 70-80 mm. between the paroxysms of pain, had 170 to 190 mm. in moderate and 240 mm. in very severe attacks. (2) A man thirty years old had a blood pressure of 65 mm. between paroxysms and of 140 mm. during the paroxysms. The climax of hypertension and pain seemed to coincide, and both passed away together. Morphin caused sleep and a lessening of the pain, but no fall in pressure. Chloral caused a hypotensive, as well as an analgesic, effect.

"Of special interest (again to quote Janeway's words) was the alternation of the abdominal and the lancinating pains. When the latter came on, the pressure promptly fell, and the visceral crises ceased. Therefore, Pal assumes that a spasm of the splanchnic vessels is the cause of pain in a gastric crisis, and that the irritation which causes the lancinating pains affects depressor fibers in the posterior roots, and the stimulus is sufficient to interrupt or cut short an abdominal crisis" (Janeway, 568, p. 247).

In this connection it is of value to know that an arteriosclerotic condition of the abdominal arteries will at times, when the pressure is high, cause a dull, aching pain in the abdomen. This increase in the blood pressure is due to the stimulation of the vasomotor nerves (the vasoconstrictor part), and is produced principally in the splanchnic area. During labor pains, also, the blood pressure is raised. Coincident with each pain it becomes higher, and varies directly as the pain. As labor continues there is a constant increase in pressure until the child is expelled, when there is a drop to a point slightly below normal. This increase of blood pressure is not due to the psychic influence of pain, for it is present even when the patient is unconscious from the administration of an anesthetic. It may be due to the following causes: (a) uterine contractions; (b) muscular contractions of the abdominal wall, causing an emptying of the splanchnics and a consequent increase of the peripheral pressure; (c) excitement when the patient is conscious. Worry may also have influence. It seems hardly reasonable to suppose that the small increase in the quantity of blood thrown into circulation at each contraction of the uterus would be sufficient (when we consider the great adaptability of the circulatory system to accommodate great or sudden increases in the amount of circulation fluid) to cause any appreciable increase in the systolic blood pressure; though the associated contraction of the abdominal muscles, and, in fact, of nearly all of the musculature of the body, it is reasonable to suppose, will produce a great elevation of blood pressure. We must bear in mind, also, the fine supply of sympathetic nerve fibers to the uterus and adnexa. After all, the increased vascular tone is, in all probability, due to this elaborate nerve supply and its irritation.

Motor Reflexes.—The reflexes produced by pain are protective in their tendency, in that they are a means of defense instituted by nature against injury. In every instance, if possible, they tend to remove the organism from the source of danger. They are very active and are constantly exerted. For instance, when the hand comes in contact with a heated object, it is immediately drawn away by a quick, automatic muscular movement, even before the individual becomes aware of the contact. In sleep many reflexes are active, and in some diseases of the cord (transverse myelitis) they may be present even when pain sensation is absent. Even in light anesthesia, this reflex-protective action is present, as is seen in abdominal operations when the parietal peritoneum is somewhat roughly handled. Although sensation is not present, the reflexes are, and, acting immediately, produce such a sudden, strong contraction of the abdominal muscles, that it is almost impossible for the surgeon to do his work. The defensive power of the reflexes is best exemplified in consciousness when the patient is under the influence of pain. The centers for voluntary muscles are thrown into activity, so that the organs, the seat of deleterious changes, may be protected from injury. Every physician is aware of the rigid contraction of the abdominal muscles in pelvic or peritoneal disease, and of the extent to which the administration of an anesthetic simplifies and renders easy a manual examination. Can anyone doubt that the higher automatisms, with appreciation of pain, are active in causing this rigidity? Almost innumerable examples of the same kind might be cited, for instance, the contraction of the muscles surrounding a joint, and its consequent fixation, in those cases in which articular inflammatory states are present, or the rigidity of the head in disease of the soft structures at the base of the skull in meningitis, etc.

In view of the universality of these defensive reflexes, it is fitting that we should be a little curious as to the reason for their presence. We know that nature is always purposeful. Every act is conservative, and we may be sure that when pain, with its attending reflexes, is present, there is a good reason for its appearance. This reason is protection against further injury. For this purpose are called into play the only reflex organs in the body capable of resistance, namely, the muscles. As a result of their stimulation and consequent contraction either rigidity or motion, or both, follow. Rigidity is best seen in the cases of abdominal diseases above mentioned; motion is best illustrated by the quick withdrawal of the hand from a source of injury.

Two of the special senses, taste and smell, owing to their functions, have developed a special sensation which is termed nausea. It is of a disagreeable, sickening nature; and finally, if sufficiently prolonged, causes a protective reflex action in the form of vomiting. This reflex, as one would judge from its intimate dependence upon the sympathetic system, is practically an involuntary act, though sometimes it can be produced by conjuring up in the mind pictures of disagreeable or disgusting objects.

Hearing, also, is somewhat different from the other senses. Here an excessive stimulant gives rise to a sensation, which, if it cannot be accurately classified as pain, is closely akin to it, because of its intensely disagreeable nature. When this sensation is present, protection from the causative agents (noises, etc.) is sought by placing the hands over the ears, so that the distressing sounds may not enter.

All of these reflexes are accompanied by certain well-marked and clearly defined changes in other systems, as the circulatory, digestive and pulmonary systems.

Complaints of Patient Compared with His Susceptibility.— A comparison of the complaints of the patient with his ability to withstand pain often gives an indication of the severity of the pain. This ability varies in different people. Some, especially those of a phlegmatic temperament, seem to be capable of bearing pain of much greater intensity than those of a nervous, active nature. Blondes, also, seem to be more sensitive than brunettes.

Personal idiosyncrasies, however, are of great value in estimating the severity of pain.

To determine the sensibility of the patient, the skin on an unaffected part of the body should be pinched between the fingers. When the abdomen is not affected, it is best, because of its great sensitiveness, to use it as a control. By the response to various degrees of pressure, an estimation can often be made of the susceptibility of the patient.

Vasomotor Signs.— Vasomotor signs, as pallor and syncope, often give an indication of the severity of the pain. These changes are due to a reaction of the pain stimuli upon the vasomotor system, and it is necessary to inquire into their cause. The vasomotor system consists of centers to which two sets of fibers are connected, namely, the inhibitory fibers and the constrictor fibers. The inhibitory fibers convey impulses which hinder the contraction, and the constrictor fibers convey impulses which stimulate the contraction of the muscular coat of the blood-vessels. It is very difficult to say in what way mental states have an action on the physical processes of the body; but that they have is evident, and that the action is a powerful one can be seen from the persistence of the induced physical changes. How the vasomotors are influenced it is very difficult to say. Yet we know that they may be influenced by many mental processes. For instance, pallor is induced by fear, fatigue, nausea, or severe pain. Redness is induced, in the process called blushing, either by a stimulation of the vasomotor inhibitory fibers or by a paralysis of the contracting fibers, producing a paralysis and dilatation of the blood-vessels of the face and neck. The vasomotor fibers pass up the cord in the lateral tracts, and pain sensation is also conveyed by the lateral tracts; so it can easily be seen how any change in the fibers conveying pain sensation would react on the vasomotor fibers and produce changes in them.

Pallor and syncope may be the indication of shock due to intense irritation of the sensory terminal filaments. According to Henderson, this shock is the result of the rapid respiration always induced by peripheral sensory irritation. In his experiments consciousness was abolished by the use of ether and morphin, so that the results were not due to consciousness of suffering, but to nerve irritation. It seems that consciousness of suffering is a mere accompaniment and not a causal element in the production of shock, which is of a reflex nature. Among other signs of shock are rapid and feeble pulse, vomiting, drawn, anxious features, and excessive perspiration. The susceptibility to shock varies. In those of a well-marked nervous temperament shock from a small injury is greater than in those of a more phlegmatic nature. Some women are almost prostrated with the pain of menstruation, while others hardly seem to mind it. The same may be said of the parturient state (Lazarus-Barlow, 571, p. 478).

Dilatation of the Pupil.—Dilatation of the pupil is produced by irritation of the sympathetic nervous system, particularly in the splanchnic area. This reaction can be made use of when estimating the tenderness of a part. Yet, in using it, one must not forget that pressure alone will produce dilatation of the pupil, especially when exerted on the abdomen, and that dilatation may also be produced by stroking or pinching the neck (Schmidt). Some idea of the dilatation due to pressure alone should be gained by stimulation of a non-painful part. Then, with this as a standard, an estimation of the dilatation due to pain can be made. This method is not available after the use of drugs, such as morphin, cocain, and belladonna, which have an action on the pupil.

Amount of Morphin Necessary to Overcome Pain.—The amount of morphin necessary to ease pain is a good indication of its severity. Colic requires more morphin than many other varieties of pain. This is especially true of gall-duct or pancreatic duct colic, and renal colic is especially noted for its persistence and severity.

Appearance of Patient.—The appearance of the patient frequently is a reliable index of the variety and severity of his pain. As a rule, pain of great severity produces a cessation of muscular movement. To this there is one great exception, namely, the pain of colic. Here, whether the colic is of urinary, biliary or intestinal origin, the patient writhes, squirms and assumes all conceivable positions, at the same time crying out or moaning. These attacks come in paroxysms, a period of quiet following each attack. In colic, also, the patient presses with his hands, or with a bolster, upon the abdomen, and frequently lies with his limbs drawn up (see Figs. 87, 88). Here the tendency to exert pressure is seen in the characteristic way in which the hands are joined, the fingers being interlocked so that greater pressure may be exerted.

This picture is the exact opposite to that seen in peritonitis, where the patient is absolutely quiet, lying flat upon his back with his limbs drawn up and hands frequently placed lightly upon his abdomen. He is very attentive, and is ever ready to ward off any touch or pressure with the other hand, (see Fig. 86). To this posture the term "abdominal protective position" has been given. Other characteristic postures are illustrated in Figs. 37, 38. Headaches also give rise to characteristic postures, as may be seen in the Figs. 66, 67, 68.

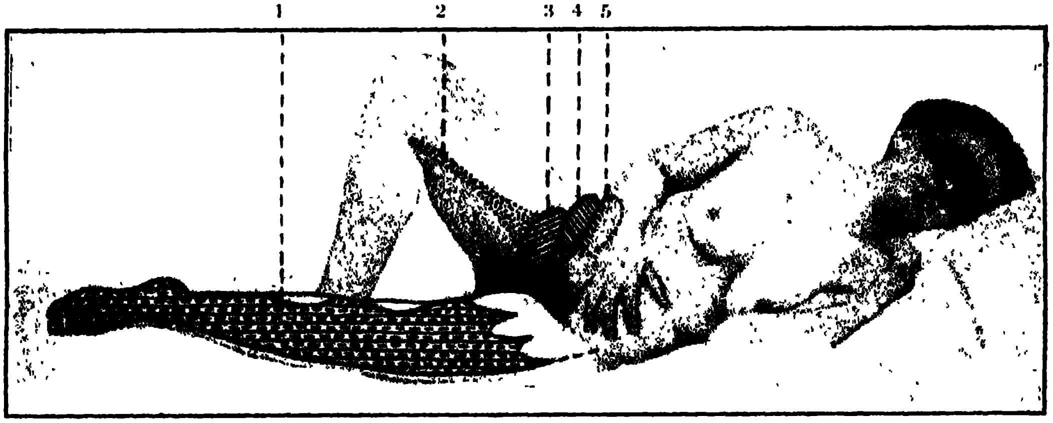

FIG. 37.—HAND PRESSING ON THE ABDOMEN IS VERY CHARACTERISTIC OF COLIC, I. E., OF THE UTERUS OR INTESTINE.

1. Area of referred pain in phlebitis (femoral). Also area of distribution of ant. crural and area of pain reference in crural neuralgia.
2. Localized tenderness in phlebitis.
3. Phlebitis (femoral vein).
   Hip joint disease.
   Psoas abscess (low).
4. Ovary inflammation.
   Salpingitis.
5. Appendicitis.

(4, Salpingitis, 5:) It is more characteristic for patient in these conditions to lie on back.

In pleurisy or intercostal neuralgia the patient assumes a rigid chest position, and, on close examination, it is noticed that the thoracic respiration is hindered. This is exactly opposite to what happens in abdominal inflammatory disease, in which the breathing is of the thoracic type, abdominal breathing having ceased entirely.

When the patient moves with considerable pain and refuses to stand on a limb, and holds the joint in a flexed position, inflammatory disease of the joint should be suspected. The position assumed in distention of the vesical bladder is one in which the patient inclines slightly forward, his back straight and rigid, pressing both hands, which are interlocked, over the lower segment of the abdomen. Tumor or aneurysm is indicated as a rule by pressure over the diseased area. In meningitis the patient remains rigid because of the pain (Ryder, 35).

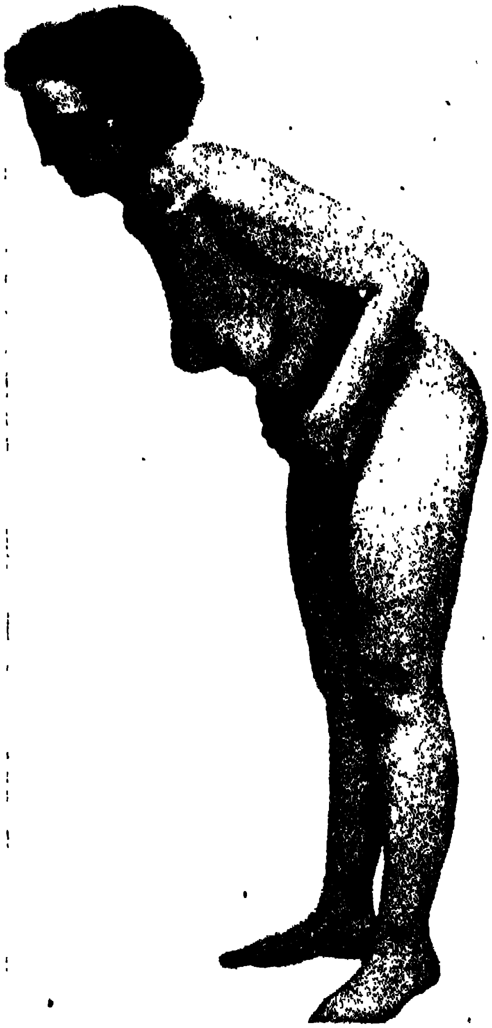

FIG. 38.—POSITION ASSUMED IN UTERINE COLIC, INTESTINAL COLIC, AND DISTENDED URINARY BLADDER.

The *facial expression* also is frequently a reliable index of the severity of pain. One expression which is indicative of the most severe pain is the so-called Hippocratic facies, in which the brow is contracted, the lips drawn back, the eyes fixed and the entire attention focused upon some intrinsic phenomenon. This is the characteristic facies of peritonitis, and when present is of serious import. In some patients, especially among those who have trained their features to express emotion, simulation is often practiced; yet, under close observation, one will notice, at times, some relaxation or change in expression, especially when the patient thinks he is not being watched.

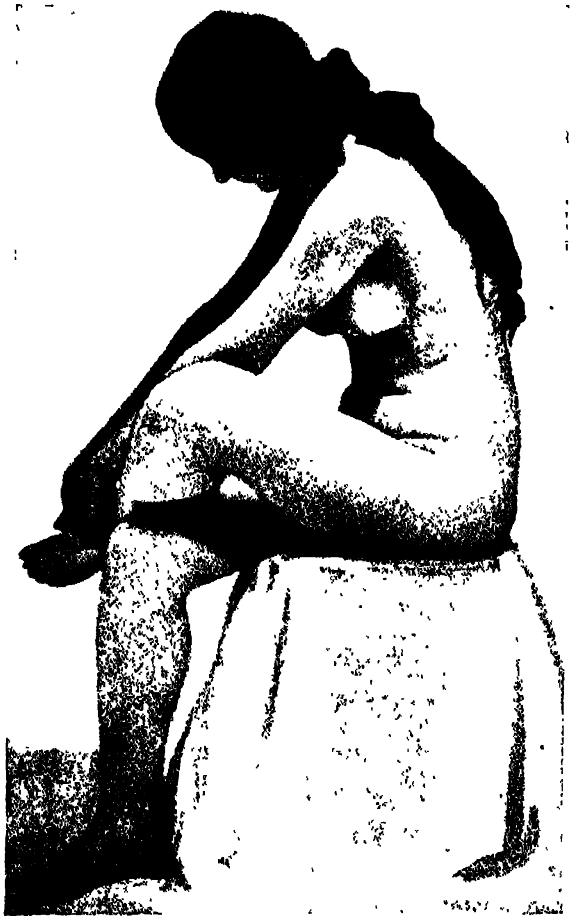

FIG. 39.—LACING SHOE POSTURE.
In lumbago, spinal caries, hip joint disease, sciatica, appendicitis and pelvic peritonitis, pain is experienced on the patient assuming this position.

Gestures indicative of pain are principally those in which the patient tries to ward off an imaginary or an actual injury. Motion as an indication of the severity of pain is of some value, but is chiefly of use in pointing to the structures which are involved. As a rule, all pains of moderate severity cause a loss of function of the part, and the patient usually lies quietly in bed, attentive but motionless, except in cases of abdominal colic, in which each paroxysm is indicated by sudden and explosive movements. In children, according to Eustace Smith, pain in the head is indicated by a contraction of the brow; in the chest by a sharpness of the nostrils, and in the abdomen by a drawing in of the upper lip (Musser, p. 79).

Patient's Description.—A patient's description of his sufferings is not of much practical assistance in deciding upon the severity of a pain. His descriptive ability, powers of imagination, and vocabulary cause it to vary greatly. One factor of importance is the persistence with which the attention of the patient is devoted to the pain, to the exclusion of other topics. Should he be consistent, and persist in his statements of its character and severity, and should his attention be not easily drawn away or occupied to the exclusion of the pain, it may be concluded that a pain of considerable intensity is present.

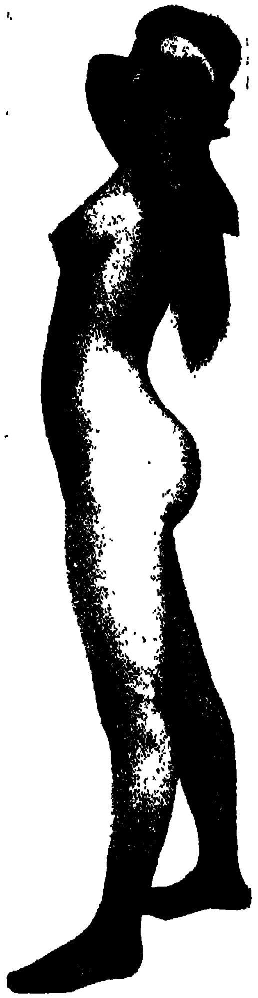

FIG. 40.—PAIN ON HYPEREXTENSION OF THE BODY.

Hyperextension of the body produces pain in inflammation of the abdominal viscera, adhesions, peritonitis, etc.

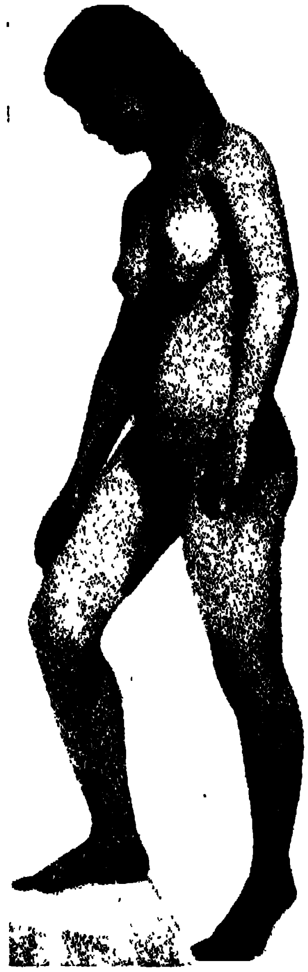

FIG. 41.—PAIN ON GOING UPSTAIRS.

When, on going upstairs, pain is present in the right limb, it indicates appendiceal abscess or pelvic inflammation, and is due to the tension of the psoas muscle producing pressure or traction on the inflamed area. The pain is greatest at the moment of raising the foot off the ground

Mechanical Factors.—Pinching, stroking, pressing are mechanical factors which are of slight value in determining the degree of pain or tenderness. These are of little value because of the variations, both of pressure and of the resistance of the patient. The best mechanical aids are electricity, the von Frey hairs, algometers, and needles.

In testing pain by means of electricity, two electrodes are used. They should be about the size of a knitting needle, and are placed from one to two cm. apart. In the following table, taken from Bernhardt, the figures showing the distances of the cylinders of the induction apparatus represent the minima of sensation, and the figures in parentheses represent the minima of pain in a healthy person:

Tip of the tongue	17.5	(14.1)
Palate	16.7	(13.9)
Tip of the nose, eyelids, back of tongue, gums, lips	11.8—14.4	(13 —12.5)
Acromion, sternum, nape of neck	13.7—13	(11.5—12.2)
Back of the arm, buttocks, occiput, loin, neck, forearm, vertex, coccyx, thigh, back of the first phalanx, back of the foot	12.8—12	(12 — 9.2)
Back of the second phalanx, back of the metacarpal bone, back of the hand, leg, distal phalanx, knee	11.7—11.3	(10.2— 8.7)
Palmar aspect of the head of the metacarpal bone, tip of the toe, palm of the hand, palmar aspect of second phalanx, hypothenar eminence, plantar aspect of the first metatarsal bone	10.9—10.2	(8 — 4)

These tables are of value in that they enable one to compare the relative sensibility of the different areas. Any decrease in the distance of the cylinders would indicate, of course, an increase in the sensitiveness of the part.

Von Frey's hairs, also used in the estimation of sensibility, are hairs which have been so selected that they bend at different pressures. They are fastened to a small wooden rod at right angles. Previous to use, the weight necessary to cause them to bend is ascertained.

In Head and Thompson's experiments, hairs sent by von Frey were used. No. 8 would bend at 830 mgms. pressure; No. 5 would bend at 360 mgms. pressure; No. 4 would bend at 230 mgms, pressure; and No. 2 would bend at 100 mgms. pressure. In the intervals between use, they should be kept in a box, with the rods supported in such a manner that the hairs do not come in contact with anything (Head and Thompson, 206, p. 542).

Algometers have been described by Head and others. A pointed instrument (as a needle) is made to press against the skin, and the amount of pressure is indicated by a scale which is attached to a resisting spring. This is the manner in which most of these instruments work. They are of considerable value, but are not yet in general use.

Needles and pins are also employed in estimating sensibility, but their use involves several drawbacks. First, the pressure exerted by them is variable and cannot be controlled. Second, the sense of touch is apt to be confused with the feeling of pain. To avoid the latter, it is well to precede the pin with the tip of the finger, so that touch may be felt first, and later hyperalgesia, if the sensibility is increased.

In making a thorough sensory examination according to Head's methods the following rules should be observed: Have the patient in an easy position and see that he is without physical discomfort, i.e., that the bladder and rectum are empty, and that he is neither hungry nor thirsty. The time of day best suited to the examination is morning, when the patient has not entered upon the work and worry of the day. Weather conditions, also, are of some importance. A bright, sunshiny day will bring more uniform and reliable results than an examination upon a dismal day. The surroundings must also be propitious. The room must be quiet, and no loud noises or talking should be permitted in the immediate vicinity. Above all, in testing the sensibility of a part, screen it from the observation of the patient. At the time of the examination the external temperature should be warm, for anything which produces goose-flesh detracts from the value of the results.

During an examination for sensibility both sides of the body should be compared. If a certain organ has been decided upon as the cause of the pain phenomenon it is necessary, in order to be sure that the decision is accurate, to reproduce the pain by traction, pressure or manipulation of the organ. Should the proper organ be engaged, a reproduction of the pain will result. Unless this can be done, and in the absence of definite pathology, it is not wise to make too positive a diagnosis. On forming a conclusion, one should not forget that the ventral aspect is less sensitive than the lateral aspect, and the lateral aspect less sensitive than the dorsal aspect of the body.

The sensations allied to pain having their basic principles in touch sensation are: (1) pleasant sensations; (2) agreeable sensations; (3) normal quiescent states; (4) disagreeable sensations; (5) pain sensations. At one end of the series we have pleasure, and at the other pain, while between the two we have all degrees of pleasant and unpleasant sensations. As the sensation becomes exaggerated at either end, we have a condition of unendurableness, for intense pleasure is just as unendurable as intense pain, and both manifest their intensity by promptly causing unconsciousness, from which the patient awakes, generally after the passing or subsidence of the causative sensation. Sometimes, following unconsciousness from pain, the patient awakes, and, the pain being present, may become unconscious again. This procedure may be repeated many times, until finally the pain-perceptive centers become fatigued or the pain disappears.

CONDITIONS ASSOCIATED WITH SEVERE PAIN

Associated with severe pain are certain symptoms which indicate to us the vast influence which a severe subjective conscious irritation may produce upon the physical entity. With extremely severe pain there are often symptoms of collapse, such as cold sweats, weak pulse, and an anxious look. These are practically the same phenomena as those which accompany any great emotion, such as fear, in which, owing to the induced fright, a vasomotor collapse takes place, the patient faints and is cold and clammy, with weak and very often rapid pulse. Happiness is also potent to cause somewhat the same condition, for we all know of the state of a man fainting from joy. In fact, in any great emotional exaltation *a temporary loss of consciousness* may occur, as in the sexual act, where in some cases the irritation to the glans or clitoris may produce such a succession of impulses that the receptive centers are overcome from the unaccustomed frequency and a temporary loss of consciousness results. The cause of this unconsciousness may be that the stimuli which are transmitted to the refraction center are referred to the periphery, and cause a vasomotor paresis which gives rise to lessened circulation in the brain.[1] As soon as unconsciousness occurs, the sensory perception is lost and the peripheral impulses to the vasomotors cease. The patient now regains consciousness, and is able again to perceive the exaggerated impulses (pain), whereupon he promptly relapses into unconsciousness. Thus an almost endless cycle is formed. The same phenomena occur in the case of extreme fear. Cases are quite common in which persons, who have become unconscious at the sight of some grewsome object, are, on recovering, rendered unconscious a second time at the sight of the same object.

It is amazing how much one can suffer and still show no signs of it by physical deterioration. It is certain that every practitioner has seen sufferers from the most severe and constant neuralgias who are robust, and otherwise seem to be in perfect health.

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[1] According to Gowers ("Clinical Lectures," third series, p. 7), sudden, intense pain, especially if felt in the abdomen or in the vicinity of the heart, may produce unconsciousness. The mechanism is supposed to be a direct action on the centers of the vagus, but syncope (unconsciousness) is only known to result if the pain is perceived. In man a cause of pain adequate to produce syncope, while the patient is under the influence of an anesthetic, has not been known. Hence, it seems doubtful whether the effect is due to a direct action on the vagal center. The facts suggest that it may be the result of a profound influence on the sensory regions of the cortex, focused on the cardiac center in the medulla.

After long periods the sufferer seems to acquire a tolerance for pain, so that he can, with a minimum of discomfort, withstand very severe attacks. On the other hand, all have seen cases in which the constant, steady and increasing pains of tubercular disease, trigeminal neuralgias, etc., have completely exhausted the patient, so that he has become thin, haggard, careworn and prematurely gray. In many cases worry and mental anxiety seem to have as much to do with the deterioration in physical characteristics of the patient as does the original pain. While the pain may not produce any apparent physical disturbance, the mental disturbances are manifold and remain more or less persistent even after the pain has entirely ceased. These mental changes are shown in irritability of temper, neurasthenia, etc.

Respiratory System.—During severe pain the respiration, as a rule, is increased, and at the same time becomes very shallow. If the pain is due to inflammatory lesions in the abdomen, the breathing is of the costal type, while if it is due to disease of the thorax, the breathing is principally abdominal in character, and the chest is fixed as though it were in splints. These conditions exist even when the patient is unconscious, showing that they are reflex acts and not in any way the result of inhibitory voluntary action.

Circulation. An acute pain is almost always associated with an increase of the pulse rate, while a chronic pain is not so frequently associated with rapidity of the pulse.

Loss of Equilibrium. Pain may be so severe that a loss of equilibrium may result, as in the case reported by Erdman (*Medical Record*, 1906, Vol. 69, p. 94), of a girl thirty-two years old, who, while at Mass, was taken with sudden, excruciating pain in the abdomen. Although she fell, she did not become unconscious. This loss of equilibrium may have been due to the fact that the stimulus produced by the pain was so great that it monopolized the entire sensorium, so that the equilibrizing perceptions from the sight, the aural, and the remaining peripheral senses were not perceived.

Trophic Changes.—Certain disturbances in muscles, joints and bones may be associated with pain. These disturbances are either (1) functional or (2) metabolic.

Both result in atrophy; the first the so-called atrophy of disuse, which results from inactivity caused by the pain, and the other an atrophy due to lack of metabolic interchange in the cells of the part. This metabolic disturbance may be in the nature of a lack of constructive power, or an increase of destructive change. In either case, the final result is a wasting and a diminution in the power of the muscle.

Preprotective Functions Associated with pain is what may be called the preprotective function, as exemplified in stomach disease, when the skin over the epigastrium, as well as the upper segment of the rectus abdominus, becomes somewhat tender. At the same time the rectus is in a state of partial contraction, and acts as a guardian, even before danger threatens. But as soon as pressure is exerted upon it the muscle hardens, and the pain, which may have been light before, now becomes acute. This illustrates how well designed is the protection of the viscera, for if the stomach itself were sensitive violence would reach and injure it before pain could be experienced, but by the interposition of sensitive structures, which are coupled to a powerful muscular reflex external to the stomach, the diseased organ is effectually guarded against external violence.

Elevation of Temperature. There is no doubt that elevation of temperature is frequently produced by pain. There also is a close relationship between the conducting paths for pain and for those of the special senses, for hemianesthesia is sometimes accompanied by impairment of the senses of smell, taste, and hearing, and amblyopia is sometimes associated with concentric contraction of the visual field on the same side of the body.

METHOD OF RECORDING PAIN

For a thorough and productive study of pain it is necessary that some reliable and simple means of recording pain phenomena should be found. This condition seemingly has been met by

Harris (84), whose method is one of the best, and, at the same time, the simplest that has so far been devised.

In his marking code, four primary characters are used: (1) a simple, unbroken line; (2) a broken line, or dashes; (3) a dot; and (4) a dot and dash. After the fourth marking Arabic numerals are used to indicate areas, centers, and radiations of pain, the numeral being placed at the point of the most intense pain and also on the line inclosing the pain area or indicating the pain radiation. Thus it may be seen that the primary characters can only be used in every fourth marking, but that the number of markings may be multiplied indefinitely. Figure 43 illustrates this.

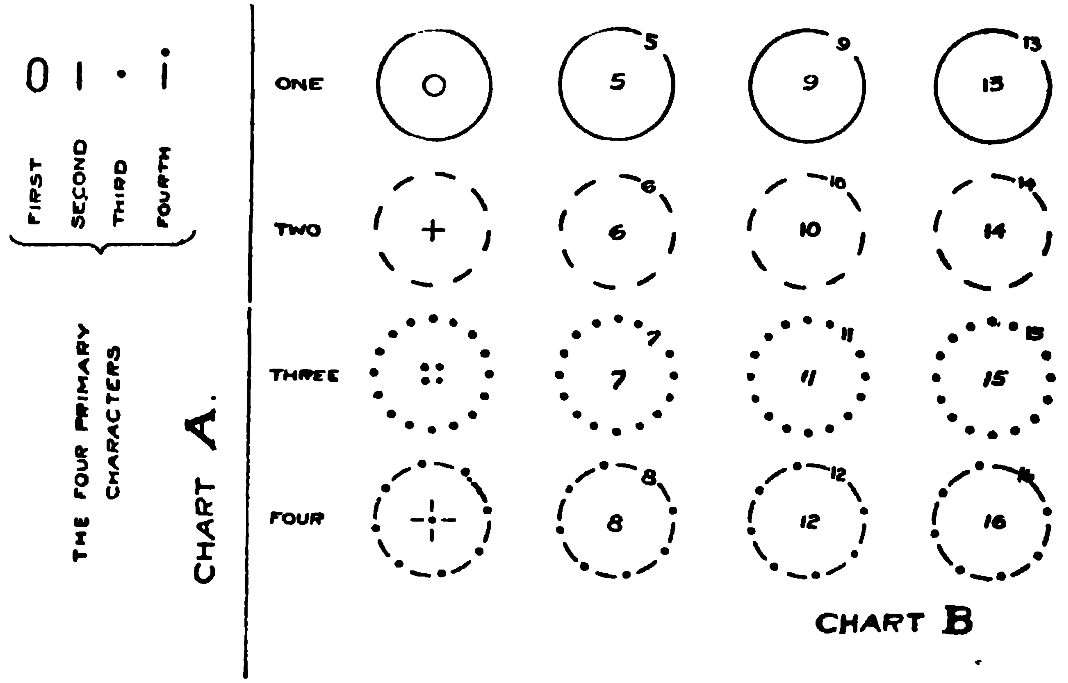

Fig. 42.—Marking Code of Dr. Harris.

"Figure I, in Fig. 43, shows the first marking upon a patient, who we assume complained of a painful area, a center pain within the area, and a radiation of pain. It will be seen that the area of pain, its more painful center, and the radiation of pain from the area of pain are constructed from the first primary character.

"Figure II, in Fig. 43, shows the second marking upon the patient who complained of a painful area with a more painful point within, which we designated as a center pain. The boun-

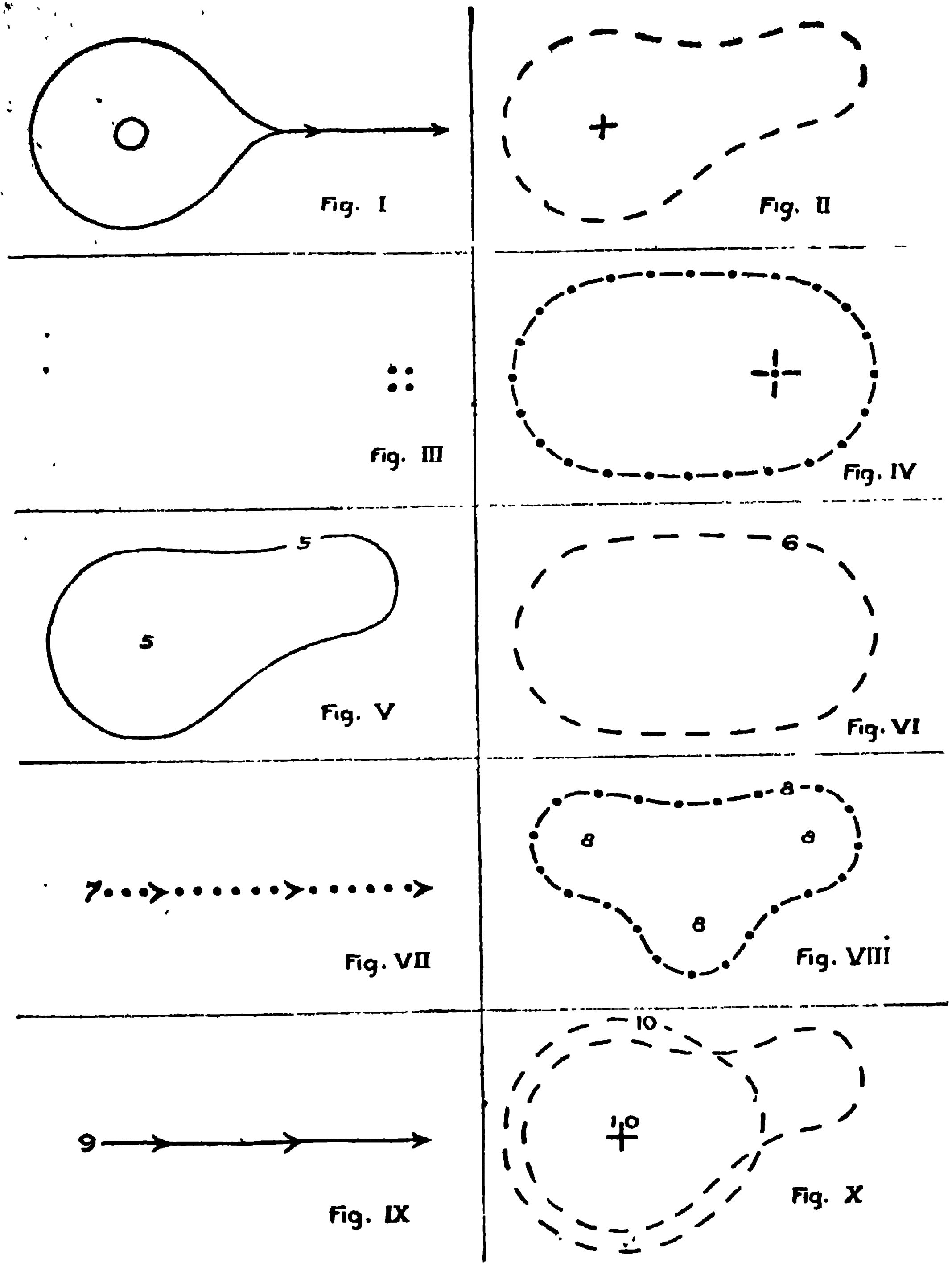

FIG. 43.—FIGURES SHOWING THE APPLICATION OF THE MARKING CODE OF DR. HARRIS.

dary of the painful area is formed from the second primary character, as is also its center of pain shown by the Greek cross.

"Figure III, in Fig. 43, shows the third marking upon the patient who complained of simply a painful point. The four dots arranged in equi-latero-quadrangular formation show the manner of marking a painful point or a center of pain from the third primary character.

"Figure IV, in Fig. 43, shows the fourth marking upon the patient, illustrating a painful area and a center of pain. The markings are constructed by using the dot and dash, which constitute the fourth primary character.

"Figure V, in Fig. 43, demonstrates a painful area and a center pain.

"Figure VI, in Fig. 43, shows the sixth marking. The dashes are employed, as in the case of the second marking, but here the insertion of the Arabic numeral 6 indicates the number of the marking.

"In Figure VII, in Fig. 13, the Arabic numeral at the beginning of the dotted line shows the painful point, and the dotted line indicates the direction of radiation.

"In Figure VIII, in Fig. 13, the boundary of the pain area is constructed from the fourth primary character, the insertion of the numeral 8 distinguishing it from the fourth marking. The location of the figure 8 at three different points indicates the location of the pain at three distinct points.

"The Arabic numeral 9 in the ninth marking of the patient indicates a painful point, while the continuous arrowed line, constructed from the first primary character, illustrates a radiation of pain from the marked painful point.

"Figure X, in Fig. 43, shows a recurrence of pain in the same region as shown by the second marking of the patient. In this tenth marking of the patient the boundary of the area of pain is constructed from the second primary character. The number 10 in the outer boundary line of the area distinguishes this boundary line from the boundary line of the second marking, which occurred in the same region having a longer and narrower area. The number 10 in this tenth marking shows the location of the center of pain, and distinguishes it from the center of pain indicated by the Greek cross of the second marking of this patient."

A permanent record may be made on the patient's chart by transferring the outlines on the patient's body to a stamped figure, being careful that the relative positions of the outlines correspond both with the bony landmarks on the figure and on the patient's body.

CHAPTER VIII

PAIN IN DISEASES OF THE NERVES, BRAIN, AND CORD

The nervous system, since it is the carrier of impulses from one portion of the body to another, and since its organization is much more delicate than that of any other structure of the body, suffers from disturbances, which, when affecting the sensory elements, are, as a rule, announced by pain. For systematic consideration the following divisions may be made: (1) nerve terminals; (2) nerves or nerve trunks; (3) nerve plexuses; (4) nerve roots; (5) cord lesions; and (6) pontine, mid-brain and cortical lesions.

AFFECTIONS OF THE NERVE TERMINALS AND NERVE TRUNKS

Affections of the nerve receptors are due, as a rule, either to inflammation, to toxemia, or to pressure. These have been considered in part in the section on parenchymatous pain (q. v.).

Affections of the nerves or nerve trunks are due, as a rule, to the following causes: (a) congestion; (b) inflammation; (c) injury (traumatism, pressure); and (d) toxemia. The milder grades may, for purposes of convenience, be termed neuralgias; the more severe affections, neuritis.

The distinctions between neuralgia and neuritis are quantitative rather than qualitative. It is largely a matter of degree. A severe neuralgia may be termed a neuritis; a mild neuritis a neuralgia. We cannot, therefore, insist upon a separation of the two conditions. One finds one or all of the causes operative in producing either a neuralgia or a neuritis and the resulting lesion depends largely upon the severity of the action of the exciting factor. Thus exposure to cold may set up a neuralgia in the facial from involvement of its sensory roots (the geniculate ganglion), or it may cause a true neuritis, involving the motor components, as well. Similarly an inflammatory reaction in a mixed nerve may cause only slight pain, the sensory components being involved but slightly, or it will bring about both sensory and motor disturbances with distinct neuritis symptoms; slight traumata, as well as toxemias, cause quite similar pictures.

Certain meningeal diseases of the cord, as well as ganglion affections, give rise to exquisite neuralgic symptoms without any of the usual motor complexities of a neuritis.

We shall here discuss the so-called neuralgia, although it should be remembered by the reader that one is continually straying into the field of neuritis.

Anstie, in his classical work on "Neuralgia and the Diseases Which Resemble It" (1871), gave one of the first English presentations of the general subject. Bernhardt, in Nothnagel's large system, has given the most extensive of recent discussions of the whole subject. However, he was incorrect in regarding neuralgia as a separate entity. It should not be so regarded, with the possible exception of a few conditions, for instance, those which cause such a change in the conducting apparatus that a light stimulus is interpreted as painful, or pain is produced without any apparent stimulus. Such a condition may follow slight chilling of the surface, or the lodgment in the nerve or its sheath of toxic substances, either heterotoxic (phosphorus or mercury), or autoxic, the result of deranged metabolism. Such a condition is present in influenza, and also in old age, when, because of impaired circulation, the tissues are not properly nourished. To these pains the term neuralgia may be applied. As early as 1873,[1] Loomis also applied the term to conditions in which there is a disturbance of nutrition. Neuralgia seems to be without recognizable pathology; at least, no uniformity exists as to the kind of pathology which is present. By some it is thought to be a form of neuritis (neuritis of the nervi nervorum, Thompson, 352), **but it** differs considerably from neuritis in its pain phenomena.

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[1] Loomis, *Med. Record*, N. Y., 1873, p. 473.

Etiology.—By many authors neuralgia is the name given to a nerve-pain which is produced by any of the following causes:

EXCITING CAUSES.—*Intraneural,* in which the exciting cause is found in the nerve fiber or its central origin. This cause may, in many cases, be the presence of toxic materials producing irritation and pain somewhat akin to the action of rheumatic poisons in rheumatic myalgia, in which the poisons act upon the terminal filaments of the sensory nerves distributed to the muscles. Under this heading we would include all those pains of infectious origin which do not result definitely from an inflammatory change in the nerves, such as occur in acute infectious diseases (influenza, tonsillitis, common colds), malaria, gout, nephritis, anemia (chlorosis), diabetes, syphilis, typhoid fever, small pox, constipation, and gonorrhea. Many consider copper, lead, arsenic, alcohol, nicotin, and mercury causes of neuralgia; others class them rather as irritant poisons with the production of neuritis. Other causes are molecular changes in the nerve itself, the character of which we do not know, although many regard them as a mild degree of inflammation. Also included under the heading of molecular disturbance pain are pain caused by exposure to cold (we are all aware of the headache produced by going against the wind on a cold day) and post-hoc-neuralgia, a term given to those conditions in which, following the removal of the cause of the neuralgia, there is a persistence of the pain, due, perhaps, to continued molecular change in the nerve substance or ganglion, which time alone can, but does not always remove. As an instance of this may be mentioned the pain persisting after removal of gall stones, after the removal of carious teeth, and after cure of a gastric ulcer. Sometimes these are called "habit pains" (q.v.).

Extraneural, under which we would include pressure by new growths, tumors, or bony processes, by foreign bodies, soft tissues, glands, bone (especially when the nerves pass through bony foramen), cicatrices, misplaced viscera, hernia, aneurysms, enlarged uterus, etc., upon the nerve.

Traumatism, such as injury of the nerve by a blow, by forcible contact with a foreign body, by the pinching of a nerve between two bones, as pinching of the intercostal nerves between two adjacent ribs. Fractures by pressure from fragments, or from the callus, cause nerve pain. Dislocation of a bone may also cause pain.

Infection has been mentioned as one of the causes, and perhaps it is the chief one. Cases of epidemic intercostal and of supraorbital neuralgia have been described, as well as the neuralgia associated with typhoid fever and rheumatism. It is reasonable to suppose that the infective germs can lodge and grow in nerves as well as in blood and interstitial tissues, for it has been definitely proven by many observers that typhoid fever germs are, in the later stages of the disease, freely circulating in the blood. Pneumococci, streptococci, and various other germs have also been isolated in pure culture from the blood; and these wandering hither and thither in the tissues locate themselves where there is the least resistance, be this in bone, tendon, nerve, or muscle. Should the nerve be the habitat, a mild neuritis is produced and this causes pain.

PREDISPOSING FACTORS leading to the production of neuralgia are inherited predisposition, the use of alcohol, tobacco and drugs, neurasthenia, and excessive sexual indulgence. Age seems also to act as a predisposing factor, those of advanced age being more susceptible than those who are younger. The other so-called pains are classified under referred, projected, sympathetic pain, *et cetera,* under which they will be described (q. v.).

Symptoms.—In the case of pain occupying any restricted area it is well to make an examination for local inflammatory changes in the skin and subjacent tissues. Should they be absent, with the skin very sensitive to light pressure and the deeper tissues not so sensitive, we may conclude that the cause of the pain is either a neuralgia or a neuritis.

If neuralgia is present there are points of hyperesthesia and the course of the nerve is not painful to pressure, while in neuritis the course of the nerve is tender to pressure, and there are no painful points. Should neuralgia be suspected, we must seek the cause, and consider acute infections, reflex irritations, as the cephalgias due to visceral disorders; referred pain, as earache due to decayed teeth; projected pain, as in the head after Gasserian ganglion resection, and sympathetic pain, when one sensory center is affected by changes in another center, and pain is felt as coming from the area of distribution of nerves arising in this center.

The pain of neuralgia may be constant and dull, or there may be periods of freedom from pain and then times of sudden and severe pain. These paroxysms of pain occur at intervals varying from a few seconds to as many weeks. The duration of an individual paroxysm varies from a few seconds to as many minutes. Sometimes, after the pain reaches its acme it becomes almost continuous and may last for weeks. The onset in many cases seems to be without any causal condition, and may be sudden or gradual. Abortive attacks may come quickly and quickly disappear. Sensations of cold, itching, and numbness in the areas of the skin, which subsequently are affected by the neuralgia, are premonitory signs of an attack. The pains are of a burning, darting, boring, cutting, piercing, biting, or pulling character. In some cases there is an intermittency in the paroxysms, which may come every day or every second or third day. When this occurs examine for malaria. The pain generally follows the course of a peripheral nerve. It may remain confined to one nerve area throughout its course, or it may suddenly shift from one area to another. At times it is confined to a small area, but most often it radiates through large areas and may run toward the periphery (neuralgia descendens), or from the periphery inward toward the centers (neuralgia ascendens).

Anesthesia dolorosa (q. v.) sometimes is present in these conditions, especially when the nerve trunk is subject to pressure due to an irritative lesion. In neuralgia tactile sensation also is sometimes lost.

Local Points.—Pressure points, first described in 1841 by Valleix, are called Valleix's points. Light pressure on these points sometimes aggravates the pain, while heavy pressure relieves it.

In other cases the reverse is noticed. Pain may be elicited by pressure with a single finger-tip.

The galvanic current sometimes produces pain when finger pressure fails to produce it. (Technique: Place the positive pole on any part of the body, preferably over some part of a nerve; hold it stationary, and run the negative pole along the course of the nerve.) In neuralgia Valleix's points are found at the point of emergence of the nerve trunks, at sections where a nerve trunk traverses a muscle to reach the skin, at the point where a nerve fiber breaks up into branches, and at points where the nerve becomes very superficial. The painful points along the course of nerves in neuralgic affections may be due to irritation of fine terminal sensory filaments, which are distributed to the sheath of the nerves (Jelliffe).

Distant Points.—"Points douloureux apophysaires" of Trousseau, or distant painful points, are also found in neuralgia. These are located in the spinous processes of the vertebra, between which the roots of the affected nerves leave the vertebral canal. The spinous processes in the region of the middle cervical vertebra are very sensitive in neuralgia of the trigeminal nerve.

While painful points vary greatly and sometimes are recognized only at the time of the paroxysm, they may exist all the time and become more painful only at the time of the paroxysm. Pressure on the painful points may in one case produce an attack, while in another case it may abort the attack. The effect is sometimes lessened, sometimes intensified, depending upon whether the pressure is light or heavy. Light pressure sometimes produces a paroxysm, while heavy pressure sometimes causes its disappearance. After the neuralgia has existed a certain length of time, atrophy of the nerve may occur and the pain may subside, especially when it is due to pressure along the course of the nerve.

Vasomotor Changes.— In acute and recent attacks, because of the contraction of the vessels and stimulation of the vasomotor, there may be at first pallor of the affected area, followed by flushing. In chronic neuralgia there is chronic flushing, due to vasomotor paresis. In later attacks there is generally flushing of the skin on the affected area. In trigeminal neuralgia there may be a pulsation of the temporal artery on the affected side. In some cases a swelling of the affected side occurs, and this in time leads to chronic thickening.

Trophic Changes. The skin is sometimes thicker than normal; or, as a rarer condition, it may be thinner, due to cutaneous atrophy. The hair on the affected side of head in trigeminal neuralgia sometimes becomes coarse or rough, and falls out, or it may become gray. Areas of gray hair may alternate with the natural-colored hair. In some cases the hair grows profusely. Other changes, as herpes, desquamation, eczema, and pemphigus, are fairly common. The secretory and excretory apparatus are also affected. Saliva and tears are often increased on the affected side in trigeminal neuralgia. Sweating is common over the affected part, and urine is often excreted in abnormal amounts. The nasal secretion in a trifacial neuralgia is at times tinged with blood.

Muscular Changes.—Atrophy of the muscles on the affected side is common. It is due to lack of motion, because of pain. This is very slow of onset, and after a certain time remains stationary. Trophic muscular changes generally indicate a more extensive involvement (protopathic system).

Muscular contractions occur; at times they are clonic, at other times tonic Slowing of the heart's action has been observed during a neuralgic attack. Movement is often impossible, because of the irritation produced in the sensory nerves. Walking and flexing of the thigh will often produce pain in cases of sciatica. Eating will frequently produce pain in cases of trigeminal neuralgia. Pupils are often dilated, the dilatation being unequal. Associated neuralgia may be present in some cases. Here the pain gradually appears on the opposite side of the face, and may then entirely disappear in the region where it commenced.

Duration of Neuralgia.—Sometimes the disease ends after one or two attacks, or it may persist for long years, even for an entire lifetime.

Diagnosis of Neuralgia.—Neuralgia can only be diagnosed by exclusion, and is only justifiable when all other causes having an anatomical basis for the pain production have been excluded, such as pressure from growths, inflammatory exudates, misplaced fragments of bone, etc. The term neuralgia is often only a cloak for ignorance. It indicates that the diagnostician has not been able to localize the cause of the painful condition. It is the same as calling a pain in the head headache, or a lesion of the heart heart disease.

Differential diagnosis of neuralgia should be made from *painful muscular lesions*. Here the muscle is tender to pressure, and there are swelling and thickening. Pain never extends beyond the region of the muscle. Inflammation of the bones or periosteum is also to be distinguished. In these there are swelling and tenderness in the bones affected. Inflammation of the joints sometimes is mistaken for neuralgia; it is differentiated by the swelling and tenderness of the joints and the pain on moving them. Neuritis from a differential diagnostic standpoint offers the greatest difficulties. It is different from neuralgia, in that neuralgia is but the name of the sensory condition, while neuritis is the name of the pathological entity which is present.

Syphilitic Neuralgia.—This form of neuralgia, because of the frequency with which it is entirely overlooked, merits separate consideration. Neuralgia may occur during any of the three stages of syphilis. During the first stage it is manifested principally by fugitive transitory pain over the entire body. It is rather an aching than a well-defined pain. In the second stage, the pain also is fugitive, is worse at night, and shows remarkable improvement under syphilitic treatment; while in the third stage the pains are more fixed and are due to pressure from syphilitic changes in the surrounding tissues (gumma, exostosis), or they are produced by changes in the nerve itself, due to syphilitic processes such as are found in locomotor ataxia.

Types of Neuralgia According to Localization. -The principal types of neuralgia, according to localization, are: (1) trigeminal; (2) brachial; (3) intercostal; (4) circumflex; (5) sciatic; (6) peroneal; and (7) visceral.

TRIGEMINAL NEURALGIA (Tic Douloureux).—Neuralgia may occur in any of the branches of the fifth nerve. In some cases lesions have not been demonstrable, but in the majority of instances some disease of the Gasserian ganglion has been found in intractable cases of tic douloureux.

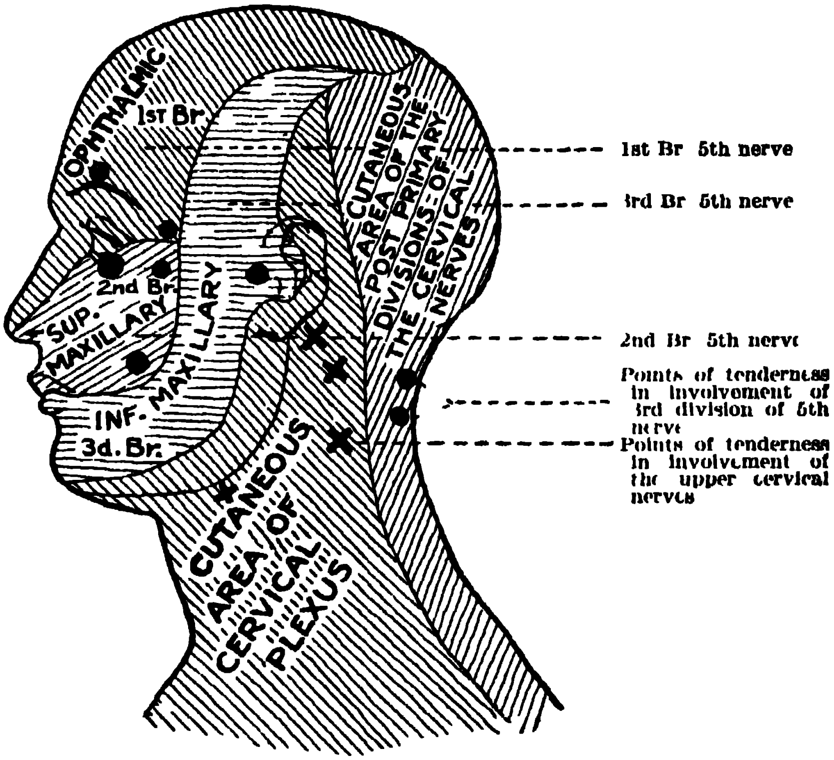
OPHTHALMIC
1st Br.
2nd Br.
SUP. MAXILLARY
INF. MAXILLARY
INF.
3d. Br.
CUTANEOUS AREA OF THE POST PRIMARY DIVISIONS OF THE CERVICAL NERVES
CUTANEOUS AREA OF CERVICAL PLEXUS
1st Br 5th nerve
3rd Br 5th nerve
2nd Br 5th nerve
Points of tenderness in involvement of 3rd division of 5th nerve
Points of tenderness in involvement of the upper cervical nerves

FIG. 44 AREAS OF NEURALGIC PAIN

The first branch involvement is seen most often by physicians, the second and third division involvement are seen most frequently by dentists. The dots indicate Valleix's points of tenderness in neuralgia of the fifth nerve The crosses indicate the points of tenderness in cervico-occipital neuralgia.

The most important of the peripheral trigeminal pains due to lesions of the nerve are in the teeth. In some cases the pain is referred to areas supplied by a different branch of the nerve than that which supplies the particular tooth. The reasons for this are not known exactly. In other cases a central pain is referred to the teeth. One of the most frequent mistakes of dentists is to consider a tic douloureux as being due to teeth disorders. The result is the extraction of all the teeth for a lesion which really is in the Gasserian ganglion.

The nose in many cases acts as a primary cause for neuralgia (referred pain) of the upper branch. Thompson mentions a case of trigeminal neuralgia which was caused by a piece of necrosed bone in the nose.

Lange calls attention to neuralgia being mistaken for incipient tabes. Diagnostic differentiation in tabes is the lack of sensitiveness of the nerve trunks, and generally the simultaneous affection of the trigeminal and occipital nerves. On the other hand, a tabes may have its initial symptom in a trigeminal neuralgia.

Blair gives the following as characteristics of trigeminal neuralgia: (a) The pain is generally sudden in one branch of the fifth nerve; (b) it is paroxysmal and always returns in the same spot; (c) it is spontaneous, or is produced by certain definite stimuli peculiar to the individual; (d) no primary anesthesia is present over the involved nerve; (e) there is no tenderness of the trunks of the involved nerve.

When trigeminal neuralgia is present in any or all branches of the fifth nerve, examine the branch involved from its area of distribution to its point of emergence on the face. True trigeminal neuralgia is due to a lesion of the Gasserian ganglion, and should not be confused with the nerve pain arising from inflammation of the nerves, tumors of the nerves, injury of the nerves, pressure upon the nerves from new growths (as aneurysm of the carotid artery), tuberculosis of the bony foramen through which the different branches pass, gummata, and malignant growths. In infectious diseases, as influenza, malaria, and typhoid fever, the severest pain is felt at the supraorbital foramen (Schmidt).

The pain of trigeminal neuralgia is probably the most severe of any to which man is heir. As a rule it is unilateral. When at its worst the sufferer may cry out, roll, and toss in his agony. With a constant, steady pain, there occur paroxysms of greater severity, which are so intense that the patient would welcome any event, even death itself, if it would relieve him. If the inferior or middle branches are involved, eating becomes an utter impossibility, and drinking is only accomplished with great distress. The patient is in constant dread, for when the pain is somewhat lessened the slightest touch, even the vibration from a slammed door, will again cause a paroxysm. These attacks last from a few minutes or hours to several days.

Valleix's points, which are present, are described by Jelliffe: (a) for the first division of the fifth nerve, as being located at the supraorbital notch, the external angle of the upper lid, the upper, outer aspect of the nose, and the globe of the eye; and (b) for the second division at the infraorbital notch, the molar bone, opposite the upper last molar, at the outer angle of the mouth, and on the roof of the mouth. The points of tenderness (c) in the inferior maxillary involvement are just in front of the auditory canal, the side of the tongue, the border of the chin, and Trousseau's points over the first and second cervical vertebral spines.

BRACHIAL NEURALGIA. - Brachial neuralgia, or neuritis, is due to a lesion of the brachial plexus. The brachial plexus arises from the anterior roots of the lower four cervical nerves and the upper half of the first dorsal nerve. These then unite into trunks, the fifth and sixth uniting to form the upper trunk, the seventh nerve forming the middle trunk, and the eighth cervical and one-half of first dorsal nerves uniting to form the lower trunk (Fig. 45). These trunks then divide into an anterior and a posterior part, the anterior portion of the upper two trunks again uniting to form the upper cord, and the posterior divisions of the upper and middle trunk uniting to form the middle or posterior cord. The inferior trunk continues as the inferior or lower cord. Each of these cords is made up of both motor and sensory nerves.

The sensory cutaneous nerves arising from the upper cord of the plexus are the musculocutaneous, from the fifth, sixth and seventh cervical roots. Those arising from the lower or inner cord are the lesser internal cutaneous, which arises from the first dorsal; the internal cutaneous, arising from the eighth cervical and the first dorsal; the ulnar, receiving its fibers from the eighth cervical and first dorsal roots; and the meridian (inner head), arising from the sixth, seventh, and eighth cervical and the first dorsal nerves. From the middle cord arises the circumflex, receiving fibers from the seventh and eighth cervical; and the musculospiral, radial branches receiving fibers from the seventh, eighth cervical and first dorsal roots. A lesion in any one of the cords of the brachial plexus may produce pain in the area of distribution of any of the nerves arising from it. A lesion on any of the nerves derived from the brachial plexus will cause pain in the area of distribution of the nerves involved. The areas of distribu-

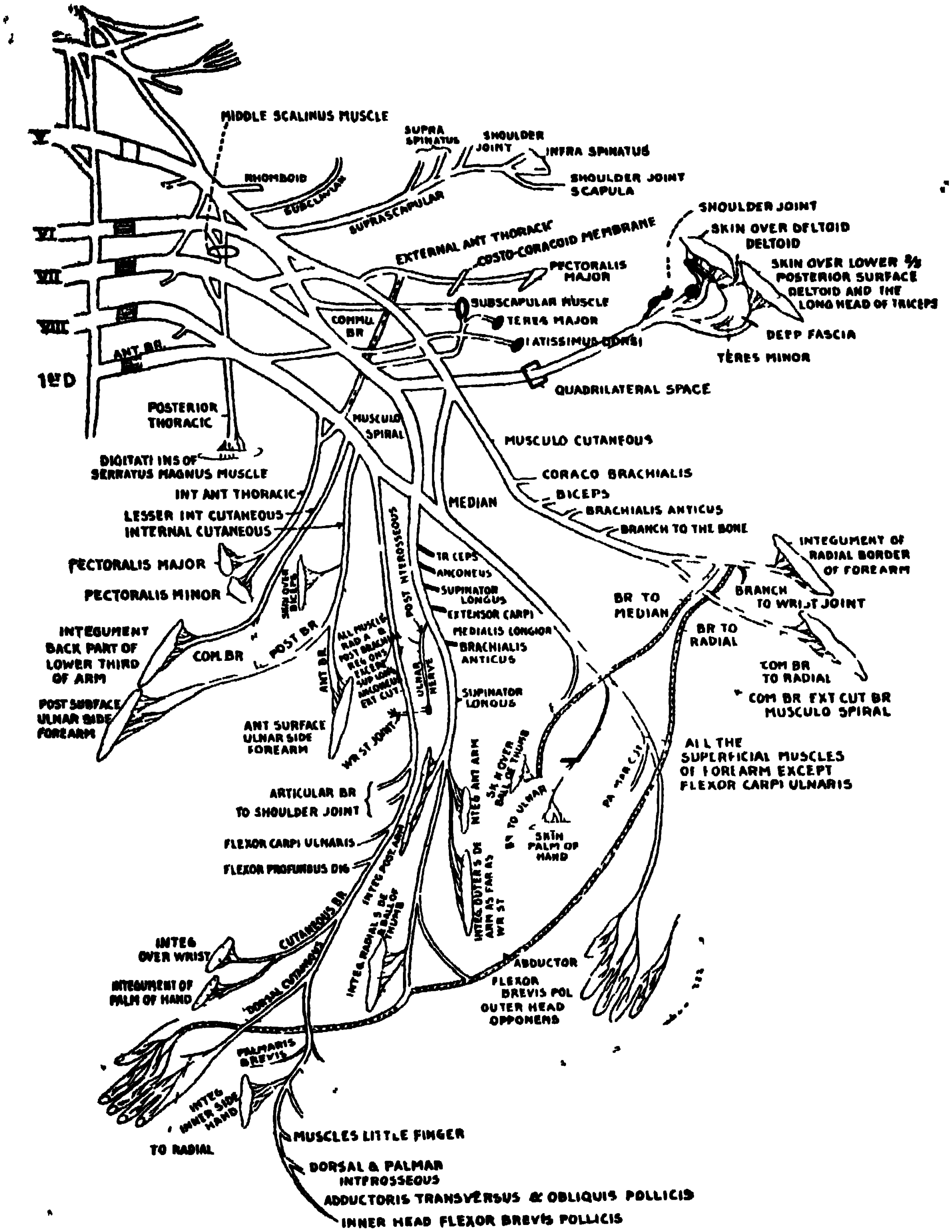

FIG 45 —BRACHIAL PLEXUS.

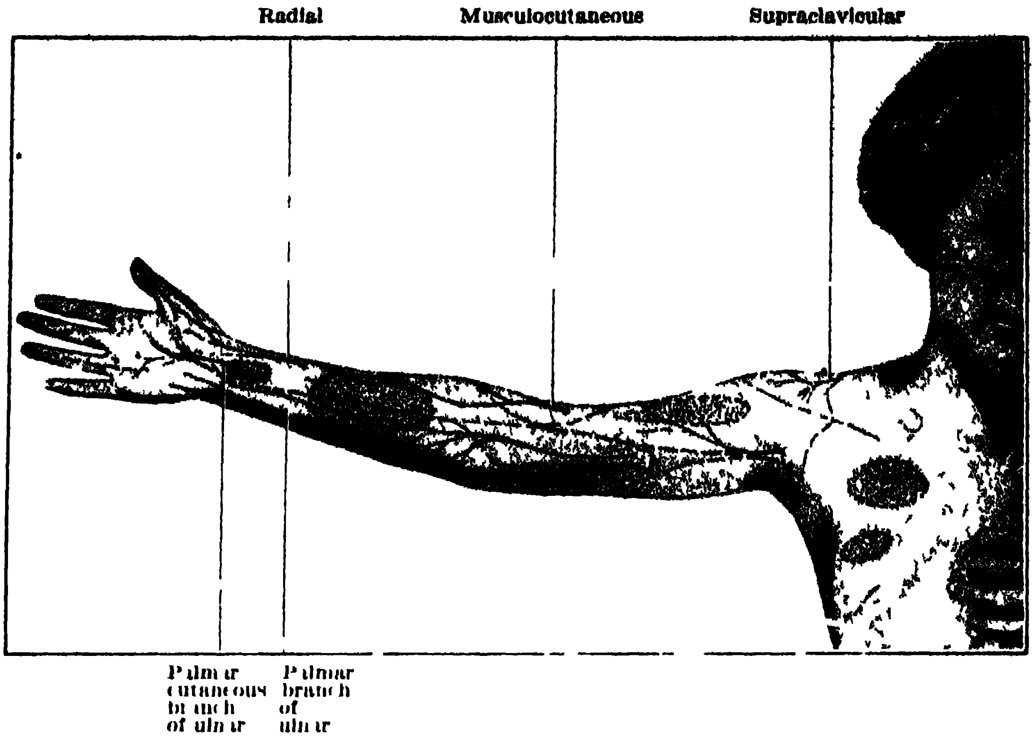

FIG. 46.—AREAS OF DISTRIBUTION OF NERVES DERIVED FROM THE BRACHIAL PLEXUS.

tion are shown in the accompanying figures (Figs. 46, 47). Should the lesion occur above the cords, and be in one of the trunks, it is very easy to define it by referring to the figures showing the

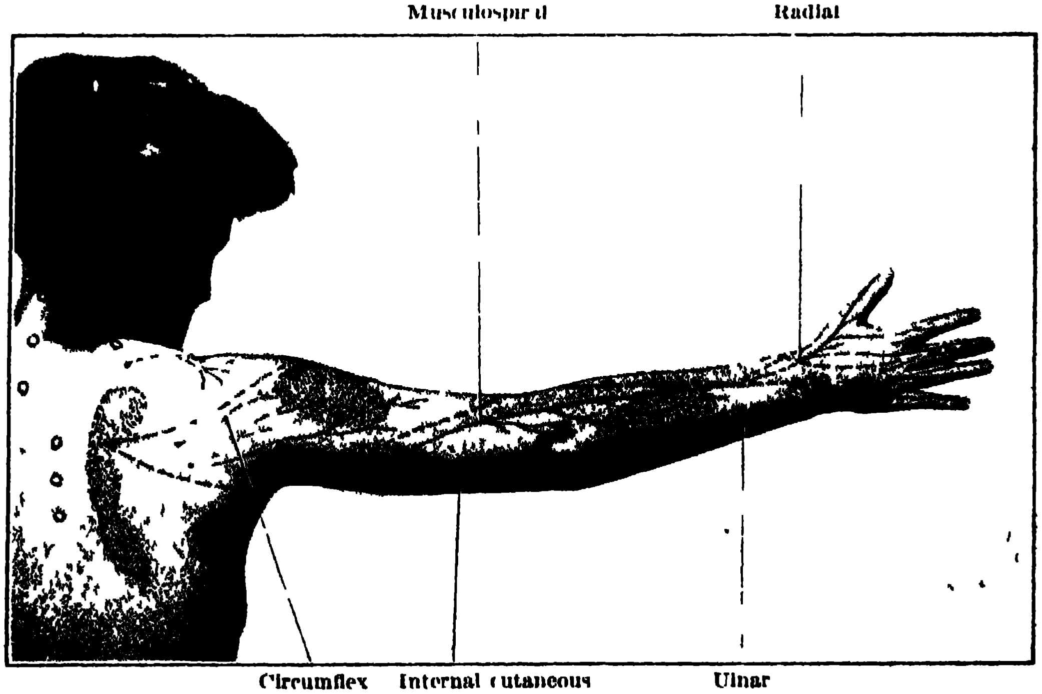

FIG. 47.—AREAS OF DISTRIBUTION OF NERVES DERIVED FROM THE BRACHIAL PLEXUS.

distribution areas of the nerves forming the brachial plexus. It is only necessary to remember that the upper trunk is formed by the fifth and sixth cervical, the middle trunk by the seventh cervical, and the lower trunk by the eighth cervical and the first dorsal nerves. These figures (Figs. 46, 47) clearly show the areas of pain in lesions of the different cervical nerves. The accompanying outlines (compiled from Piersol and Gray) show the nerve roots from which the divisions of the brachial plexus are derived, and are very useful in localizing neuritis, which affects both the motor and the sensory fibers of the nerves involved.[1]

Posterior thoracic.....	5 cervical	6 cervical	7 cervical	8 cervical	....
Suprascapular	5 cervical	6 cervical	....	....	....
External anterior thoracic.............	5 cervical	6 cervical	7 cervical	....	....
Internal anterior thoracic..............	......	....	....	8 cervical	1st D.
Subscapular.........	5 cervical	6 cervical	7 cervical	8 cervical	....
Circumflex........	5 cervical	6 cervical	7 cervical	8 cervical	....
Musculocutaneous ...	5 cervical	6 cervical	7 cervical	8 cervical	1st D.
Median............	....	6 cervical	7 cervical	8 cervical	1st D.
Lesser internal cutaneous...........	....	....	....	....	1st D.
Internal cutaneous....	....	....	....	8 cervical	1st D.
Ulnar...............	....	......	....	8 cervical	1st D.
Circumflex..........	5 cervical	6 cervical	7 cervical	8 cervical	1st D.
Musculospiral	....	6 cervical	....	8 cervical	1st D.

These primary distribution areas are represented in the outlines in such a manner that they clearly define the area of distribution of the different nerves forming the brachial plexus. Dia-

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[1] The table may be used to define the cervical nerve, root or cord zone involved; for instance, suppose pain was felt on the ulnar side of the arm and over the shoulder, on referring to the figure one sees that the pain is in the area of distribution of the ulnar and circumflex nerves, and on referring to the table one sees that while the circumflex arises from the seventh and eighth cervical and the first dorsal, the ulnar arises only from the eighth cervical and first dorsal. The lesion may involve the seventh and eighth cervical, and the first dorsal, but if it involves the first dorsal, the lesser internal cutaneous would also be involved. Since it is not, the first dorsal must be excluded. Examination of the internal anterior thoracic will show whether the eighth cervical or the seventh cervical are the ones affected. If it is involved in the pain phenomena also the eighth cervical is the nerve affected.

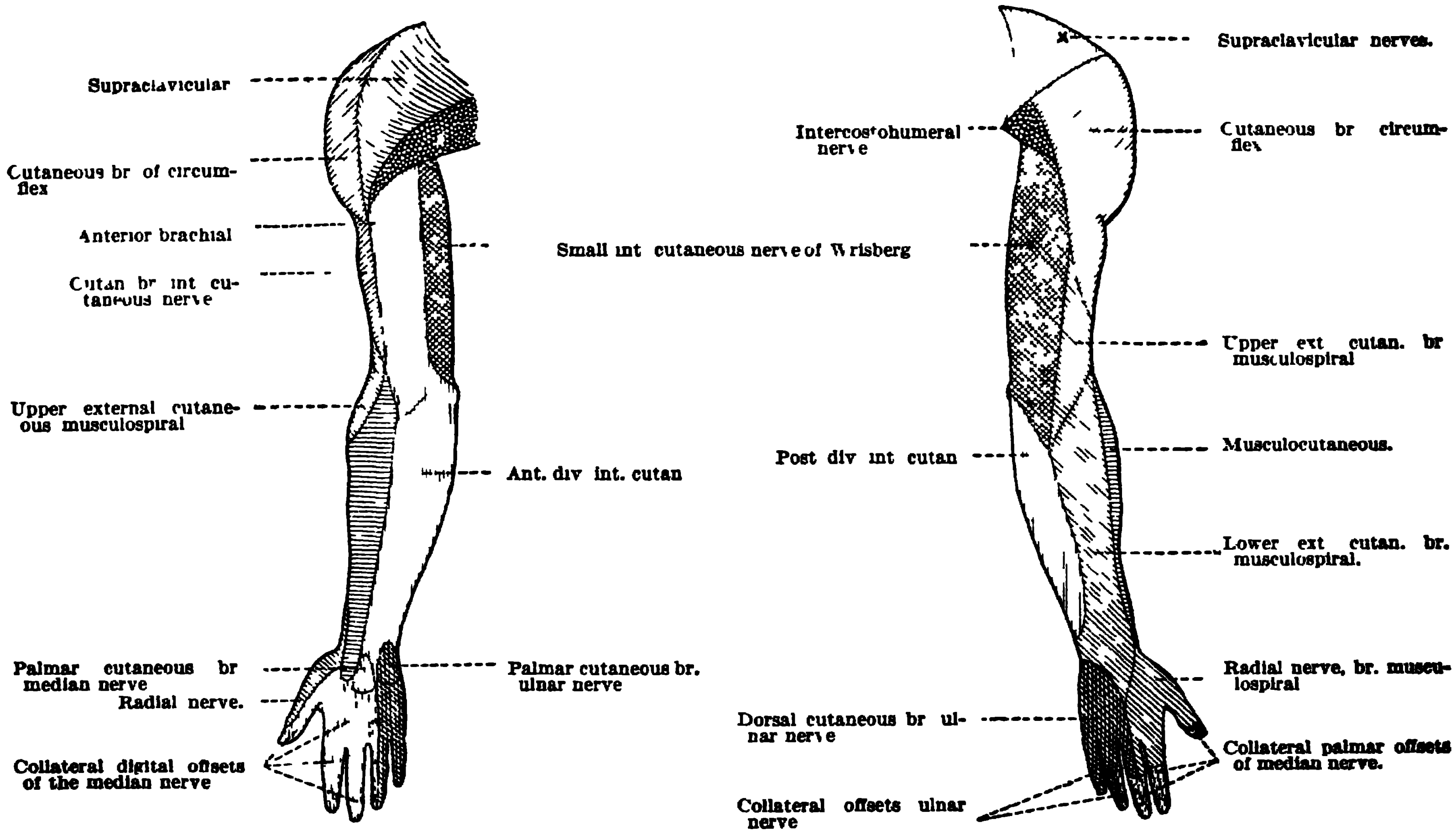
Supraclavicular
Cutaneous br of circumflex
Anterior brachial
Cutan br int cutaneous nerve
Upper external cutaneous musculospiral
Palmar cutaneous br median nerve
Radial nerve.
Collateral digital offsets of the median nerve
Small int cutaneous nerve of Wrisberg
Ant. div int. cutan
Palmar cutaneous br. ulnar nerve
Intercostohumeral nerve
Post div int cutan
Dorsal cutaneous br ulnar nerve
Collateral offsets ulnar nerve
Supraclavicular nerves.
Cutaneous br circumflex
Upper ext cutan. br musculospiral
Musculocutaneous.
Lower ext cutan. br. musculospiral.
Radial nerve, br. musculospiral
Collateral palmar offsets of median nerve.

FIG. 48.—DISTRIBUTION AREAS OF THE CUTANEOUS NERVES OF THE UPPER LIMBS.

grammatic outlines of the distribution area of the cords composing the brachial plexus are shown in Figures 48-53. A lesion on one of these nerves would produce a disturbance in the entire distribution area of the nerve below the point involved.

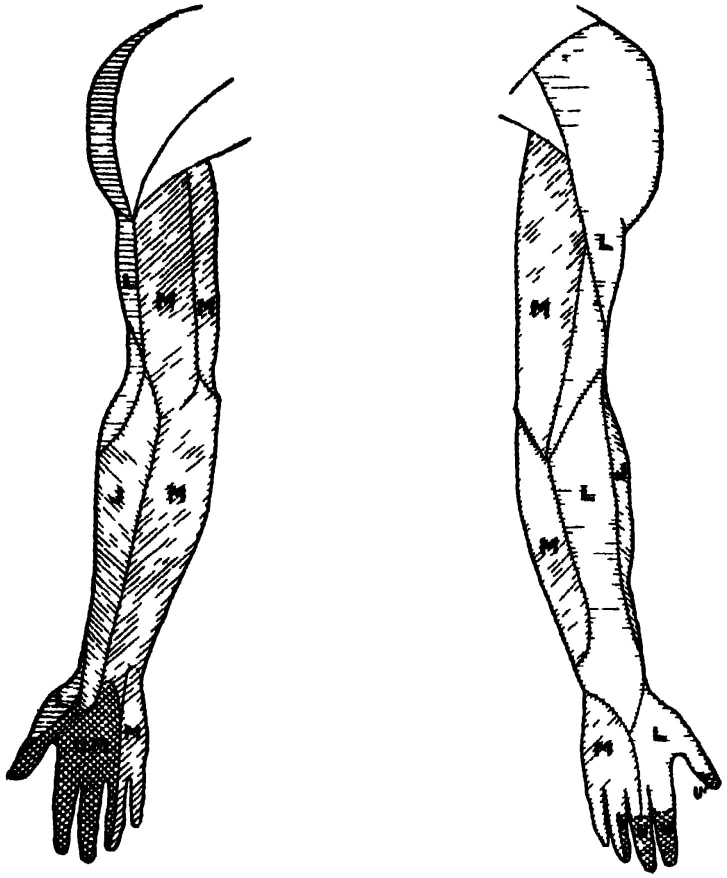

FIG. 49.—AREAS OF DISTRIBUTION OF THE DIFFERENT CORDS OF THE BRACHIAL PLEXUS

The areas marked U are supplied by the upper cord. Those marked M by the middle or posterior cord, while those marked L derive their supply from the lower or inner cord The area containing crossed lines and marked U M is supplied by both the upper and lower cords

When the pain is bilateral, and affects the areas of one or more segments (see figure showing cord zone distributed) of the cord, disease of the vertebra or tuberculosis should be looked for; or, if it affects the cord itself, tabes should be sought. The association of herpes indicates involvement of the posterior ganglia.

Unilateral pain occurring (a) within the boundaries of a particular cord-distribution area, (b) within the distribution area of a cord trunk, or (c) of one of the cervical nerves, or (d) even of the nerves given off from the brachial plexus, should always

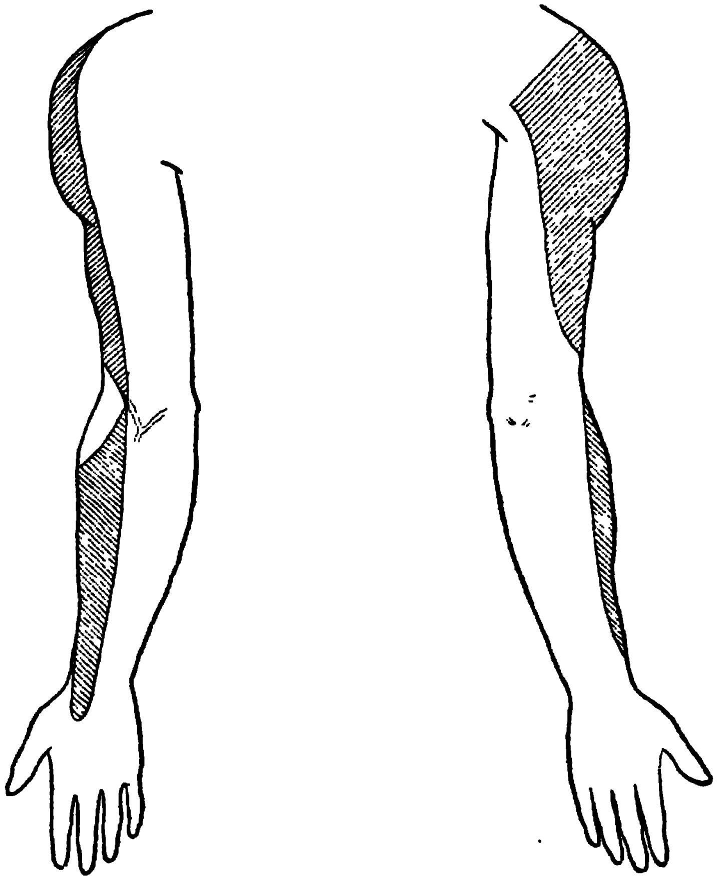

FIG. 50.—DISTRIBUTION OF SENSORY DISTURBANCES IN A LESION OF THE FIFTH CERVICAL NERVE.

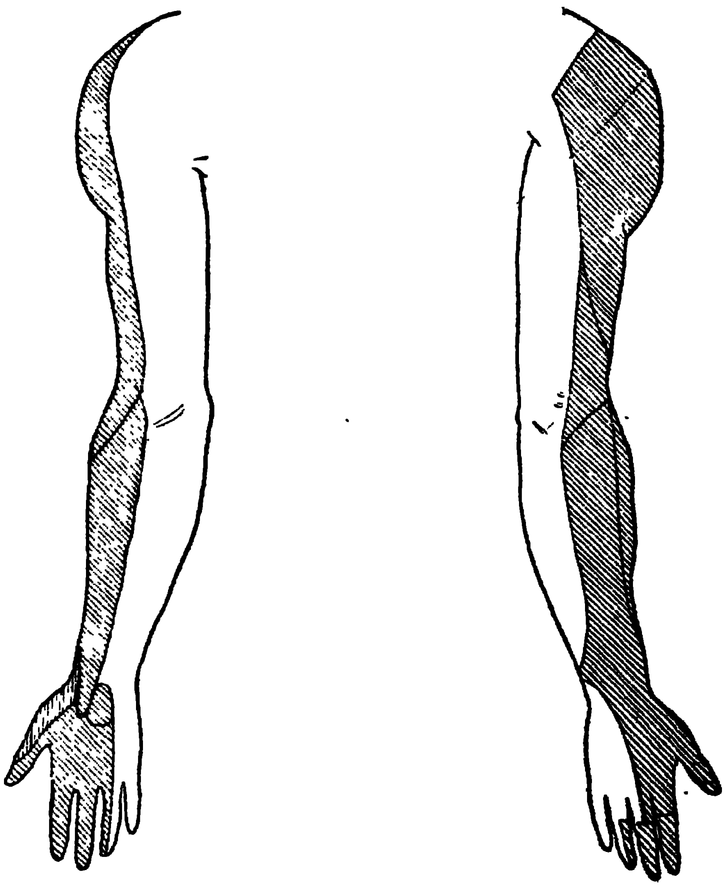

FIG. 51.—AREA OF DISTRIBUTION OF PAIN IN LESIONS OF THE SIXTH AND SEVENTH CERVICAL NERVES.

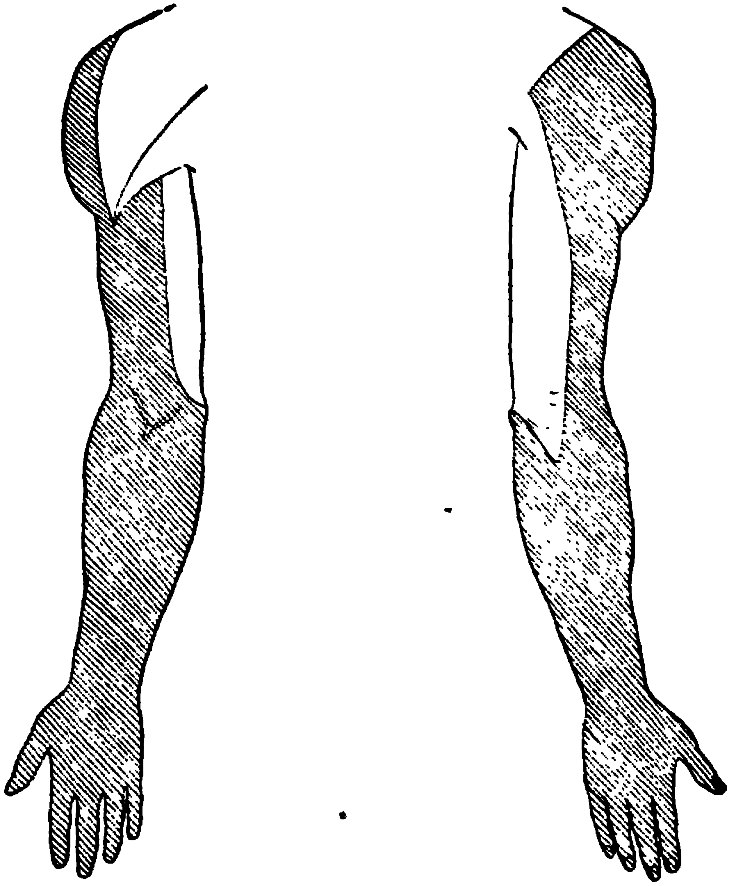

FIG. 52.—DISTRIBUTION OF SENSORY DISTURBANCES IN LESIONS OF THE CERVICAL PLEXUS.

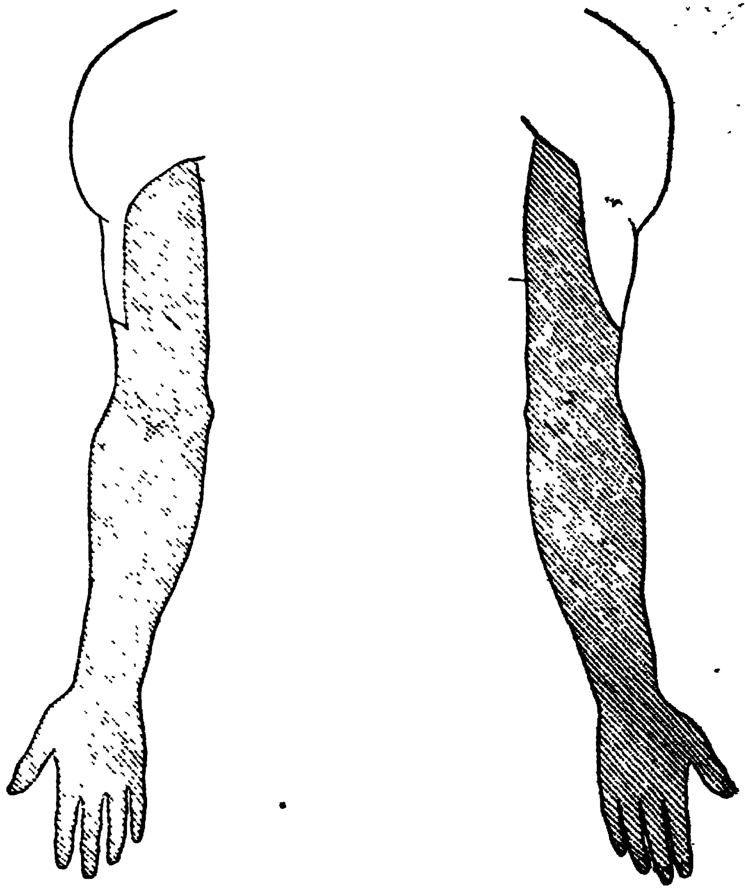

FIG. 53.—AREA OF ANESTHESIA IN A LESION OF THE FIRST DORSAL NERVE

cause a search to be made for the lesion in the special nerve segment in which it has been localized. Lesions causing such a condition are those producing pressure, as axillary tumors, sarcoma, aneurysm of the subclavian or axillary artery, abscess, and enlargement of the cervical and axillary lymph glands. Owing to the close relationship of the trunks and cords forming the brachial plexus, it is very unusual for one to be affected to the exclusion of the others.

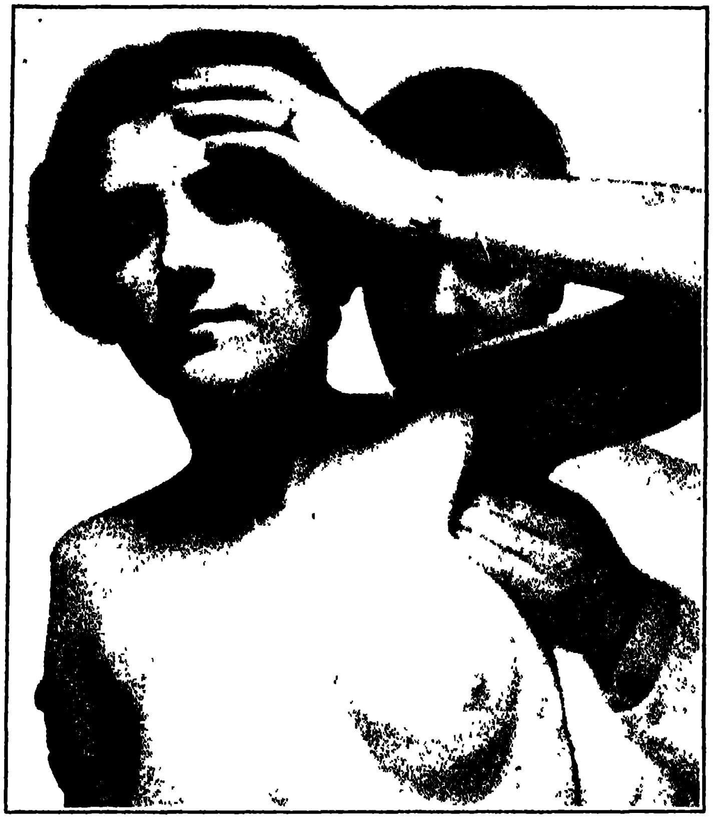

FIG. 54.—METHOD OF ELICITING PAIN IN BRACHIAL NEURALGIA.

A method of making pressure on the brachial plexus and so causing pain to appear in the distribution areas involved is shown in the figure.

All of the instances given here are not, in the strict sense of the word, true cases of neuralgia. The term neuralgia should be used only to define those lesions of the nerves giving rise to pain and in which there is no apparent pathology. Such a condition is found in anemia and toxemia. In other cases pain produced by pressure is referred to the area of distribution of the nerve, and is a *referred pain*, while pain resulting from an adjacent inflammation is due to a neuritis or to pressure from the inflammatory exudate. Both cases resemble referred pain; but since it is common to consider these pains under neuralgia, and neuralgia itself means pain, they have been placed under this heading. In cases in which inflammation is the cause of the neuralgia a considerable part of the local pain is as much the result of the inflammatory invasion of the connective and muscular tissues of the affected part as it is of nerve involvement; indeed, it is probable that every one of the above so-called neuralgias will be found to be a neuritis.

The pain in brachialgia is similar to all other neuralgic affections. It generally occurs in sharp paroxysms, in the intervals between which there is no pain; yet, in some cases, the pain may be constant, and of a dull, aching type. In all cases sharp paroxysms of greater severity occur at regular intervals. In the early stages of the disorder, the pain is a dull, generalized aching, and involves the entire arm; then, as the attack persists, it becomes localized to the distribution area of one or more of the cords of the brachial plexus (page 155). The pain may be so severe that the patient cannot sleep, and even though he should momentarily doze he is awakened by sharp paroxysms of pain. All sudden and forcible motions make the pain worse, but gentle manipulation is painless. In brachial neuralgia, stretching of the arm causes pain in the region over the posterior margin of the scapula. The paroxysms frequently come on at night and it is nothing unusual for the patient to awake in the morning suffering from arm pains of the greatest intensity.

The attacks may last for a short time, a few minutes, or a few hours; then again, they may be present for weeks or months, during which time the pain may be interrupted by periods of rest or aggravated by paroxysms of great severity. An individual attack lasts, on an average, almost two or three weeks. The patient seeks rest, and it is common to find him sitting in an armchair, nursing the diseased arm with the sound one. In some cases the patient lies down and places the arm across his chest or abdomen.

Location of the Pain.—In brachial neuralgia the pain may involve the entire arm, but generally only the upper part of the arm and the shoulder are most severely affected. The reason for this is that the circumflex and the internal cutaneous nerves supply the shoulders and the upper part of the arm, and are the most subject to injury.

Should the pain be entirely above the shoulder, it is due to involvement of the acromial and clavicular branches of the fourth cervical. If the pain is over the shoulder, or is at its anterior and outer aspect, it indicates involvement of the circumflex (Figure on page 154). Since the shoulder joint is also supplied by the circumflex nerve, movement of the joint may cause pain in the distribution area of this nerve. If the circumflex is involved the pain is confined to the cutaneous area of the distribution of this nerve; but should the pain be the result of a lesion of that part of the cord from which the circumflex arises, the pain is felt also down the arm in the area of distribution of the musculospiral nerve which arises from the posterior cord in common with the circumflex. Should the pain in the area of distribution of the circumflex be associated with pain over the scapula, under the clavicle or in the neck, it indicates that it is the fifth root which is involved. In disease of this root pain may also extend down the arm in the distribution of the musculocutaneous nerve.

Pain on the ulnar side of the arm, extending almost half-way around and involving the hands and fingers, except the dorsal and external surface of the thumb, the index finger, and the adjacent surfaces of the index and the ring fingers, indicates involvement of the middle cord of the brachial plexus. Pain in the radial side of the forearm generally indicates involvement of the upper cord of the brachial plexus. Depending on the location of the lesion, the muscles may or may not be involved. A square block has been placed on the upper trunk of the brachial plexus, just before it divides into the musculocutaneous, and the branch helping to form the median. A lesion at this point would not disturb the muscular and cutaneous supply of the nerves given off above this level, while the supply given below this portion would be disturbed in the manner described above. By placing a block on any part of the nerve, the resulting disturbance can easily be ascertained.

In the early stages of brachialgia the pain is diffused over the entire arm, forearm and hand, and runs down into the fingers, though it usually involves only the first, second and third fingers (Dana). According to Dana, neuralgic pain in the forearm is very rare.

Tenderness.—Neuralgia, in the absence of neuritis, causes little or no tenderness along the course of the nerves, nor over the site of the brachial plexus, though there are well-defined tender areas in which points of maximal tenderness are located. According to Dana, these areas of maximal tenderness do not always correspond with the tender points of Valleix. It is common for patients to rub those tender areas with some form of liniment in the endeavor to ease the pain. It is needless to say that this procedure is productive only of irritation and inflammation at the site of the rubbing, without any alleviation of the pain. Others engage masseurs, who put the patient through a course of treatment, generally with a negative result, though in some cases they irritate the nerves, and increase, instead of decrease, the pain.

The tender areas are located on the anterior and posterior surface of the arm and shoulder. Those on the anterior surface are found over the outer third of the clavicle and infraclavicular fossa, over the deltoid, at the outer surface of the arm, over the inner surface of the arm just above the elbow, over the middle of the forearm, and (one) over the wrist (Gowers). On the posterior surface the areas are found over the scapula in the supraspinatous fossa, over the posterior margin of the scapula, over the upper surface of the arm where the arm and the shoulder join, over the middle of the arm, and over the middle part of the forearm. The areas along the posterior margin of the scapula are in close relation with the points of tenderness of occipital neuralgia. They lie over the second and third cervical spines. They are also closely related to the points of tenderness of cervicobrachial neuralgia, which lie over the first or second dorsal spines (Trousseau), and of brachial neuralgia, whose points of tenderness lie over the third and fourth dorsal spines.

Associated symptoms may be present, but they are not common unless a neuritis is present. When that is present there are

DIFFERENTIAL DIAGNOSIS

SYMPTOMS	NEURALGIA	NEURITIS	RHEUMATISM	HYSTERIA
Pain.	Paroxysms may occur alone or be associated with a constant pain.	Constant.	Constant in inflammatory rheumatism and is throbbing in character.	Various types.
Location of the pain.	In certain rather ill-defined zones and areas corresponding roughly to the different cords and trunks forming the plexus; may also correspond to the distribution of the nerve or nerves involved.	Corresponds to the area of distribution of the nerve or nerves involved.	In the muscles or in the joints.	At any place, no definite or well-marked location.
Motion.	If gentle, generally is without pain; violent motion is painful.	Not painful unless traction or pressure is made upon the affected nerves.	Always painful.	Generally not painful.
Tenderness.	Tenderness is present in well defined areas.	Tenderness marked along the course of the affected nerves.	The affected muscles or joints are very tender.	Tenderness marked in certain well-defined areas which are hyperesthetic. Anesthetic areas may also be present.

DIFFERENTIAL DIAGNOSIS—*Continued*

SYMPTOMS	NEURALGIA	NEURITIS	RHEUMATISM	HYSTERIA
Muscular atrophy and paralysis.	Absent in true neuralgia.	Present in later stages.	Absent.	Absent.
Reflexes.	Normal.	Increase at first, then decrease.	Present.	Normal.
Temperature.	No elevation.	Sometimes a slight elevation.	Slight.	Generally none.
Herpes.	Absent.	Present, when the spinal ganglion is involved.	Absent.	Absent.
Class of people affected.	All classes.	Hard workers and those exposed to inclement weather.	Those subject to exposure.	Neurotic.
History.	Generally follows an overuse of the arm.	Of poisoning, cold, or infectious disease.	Previous attack.	Neurotic temperament.

generally some muscular paralysis and atrophy. At first the elbow jerk is a little exaggerated, and then becomes decreased, and anesthesia is absent. In brachialgia these changes, if present at all, are a later development. In the early stage no physical change can be noticed in the arm except a slight swelling and some flabbiness of the tissues.

Circumflex Neuralgia.—Circumflex neuralgia is more common than one would naturally suppose, and of all neuralgias it is probably the most frequently wrongly diagnosed, and often mistaken for rheumatism of the shoulder joint. From this it is to be distinguished by the absence of swelling in the joint, the more or less intermittent pain, presence of exacerbations, etc. Perverted sensations are also present, as tingling, burning, and numbness. Tenderness over the deltoid and teres muscles is present, and is very severe over the line of the nerve. The causes of circumflex neuralgia, according to Disna (598), are toxic materials (as arsenic), infections (as tuberculosis), diabetes, rheumatism, gout, draughts, injury to the shoulder, blows across the deltoid muscle, fracture of the surgical neck of the humerus, and dislocation of the shoulder joint.

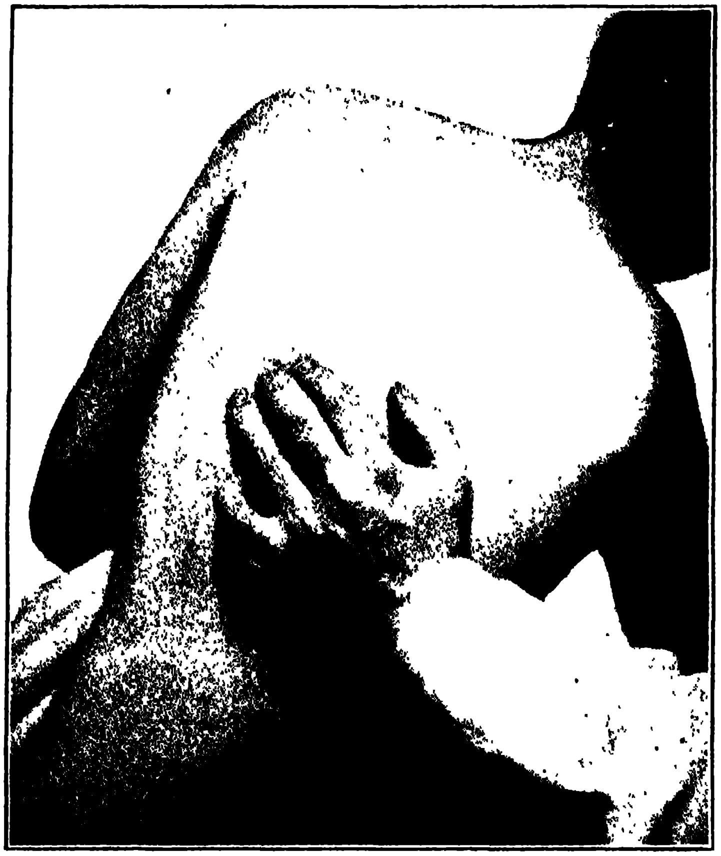

Fig. 55. Method of Eliciting the Points of Tenderness in Intercostal Neuralgia.

Intercostal Neuralgia.—Intercostal neuralgia occurs, as rule, rather suddenly, and comes on after exposure to cold, etc. It appears in paroxysms, which are very severe while they last, the pain seeming to extend around the chest. Any exposure to cold excites a paroxysm. Pressure pain over the nerve is present, and it is specially marked (a) near the spinous process of the vertebra; (b) near the mid-axillary line; and (c) behind the left margin of the sternum. Herpes zoster is frequently confused with this condition. The pain may last from one to several days, then gradually becomes less and less severe, and finally disappears. Frequently after its disappearance a feeling of soreness remains. Pleurisy without effusion is often confounded with intercostal neuralgia. A point of difference is that in intercostal neuralgia the pain increases when the patient bends over toward the affected side, while in pleurisy the pain decreases (Schepelman, 24b, p. 1078).

DIFFERENTIAL DIAGNOSIS BETWEEN INTERCOSTAL NEURALGIA AND PLEURISY (SCHEPELMAN)

	INTERCOSTAL NEURALGIA	DRY PLEURISY
Character of Pain—	Sticking, burning or lancinating -paroxysmal.	Sticking and lancinating, but occurs on breathing.
Radiation of Pain—	Often to the inner side of the arm.	None.
Location of Pain—	In intercostal spaces.	Over an infected area of the pleura.
Pressure Points—	(a) Near to the vertebra at the back of origin of the intercostal nerves. (b) Axillary line. (c) Sternal line.	Over the infected area of the pleura.
Pressure—	Touch and pressure are very painful on the affected nerves.	Painful over the area of the diseased pleura.

	INTERCOSTAL NEURALGIA	DRY PLEURISY
Galvanization—	Reduction of the pain.	No change.
Herpes—	Often occurs.	None.
Rubbing Sounds (*Friction Fremitus*)—	Absent.	Present.
Breathing, *Coughing*	....Not so painful	Very painful.

SCIATICA.—By many sciatica is thought to be a neuritis, while others consider it a form of reference pain from some lesion, occurring along the course of the sciatic nerve. In some cases the sacroiliac joint becomes diseased; and since the lumbo-sacral nerve passes over it, any disturbance of the joint will affect the nerve. Sometimes, also, a spicule of bone from an osteoarthritis of the spine may press on the nerve. Pressure by a tuberculous abscess will also cause this condition (Adams, 603). Sciatica often follows a fall or an injury, and is the result of infections, constipation, sudden changes of temperature, etc. Women are less frequently affected than men, in the proportion of one to four. It is most frequent after the age of forty, and up to sixty years of age (Duckworth, 604).

THE PAIN.—The pain is constant, with severe paroxysms, which generally occur at night. At the time of the paroxysms the pain is sharp and lancinating. Between the paroxysms it is dull and aching. Frequently it comes on after exposure to cold, or following an injury. As a rule it does not last longer than a few months, though it may persist for a year. Because motion increases the pain, the patient tries to ease the weight on the affected side, and holds up the pelvis toward the sound side, thus flexing the trunk toward the diseased side and producing a static scoliosis.

Location of the Pain.—The pain is felt principally in the back of the thigh, and runs down the leg, following the course of the sciatic nerve. Sometimes it is over the sacral or lumbar area. Frequently, on motion, pain is felt at the sciatic notch.

The cause of this pain is the pressure of the nerve against the rim of the sciatic notch by the inflamed and contracting pyriformis muscle (Bashinger, 601). The tender points (Valleix's points,

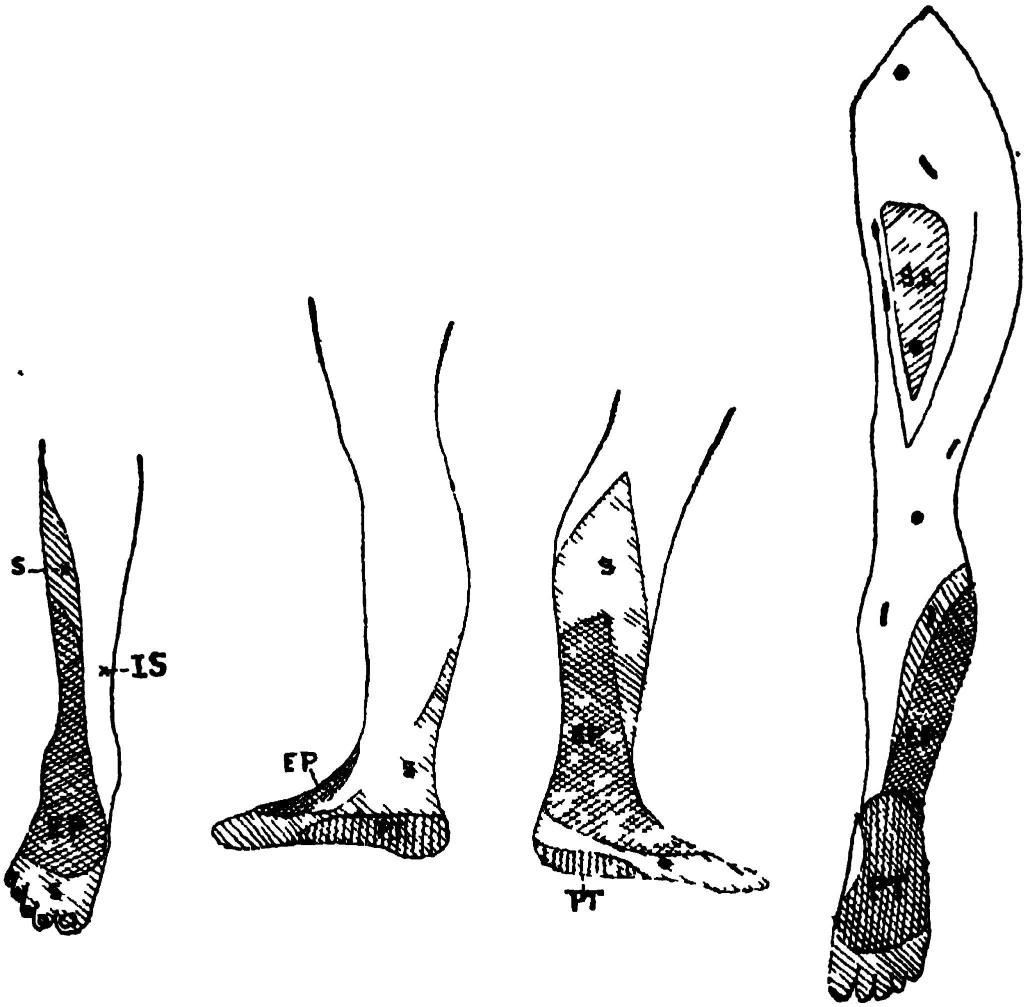

FIG. 56.—CUTANEOUS DISTRIBUTION AREAS OF THE SMALL AND GREATER SCIATIC

SS=small sciatic, EP external popliteal, PT- post tibial, S—sciatic, IS = internal saphenous, EP and PT are branches of the great sciatic These drawings are composites from those given by Head and Thompson and represent the areas in which sensation was lost after division of their respective nerve supply, consequently they would also represent the areas in which pain would be felt in any painful lesion of the nerve. These areas correspond rather closely with those given by McKenzie (599).

according to Edinger) are located: (1) over the anterior superior spine of the ilium; (2) in the center of the posterior surface of the thigh; (3) just inferior to the lower margin of the gluteus maximus; (4) in the middle of the calf of the leg; (5) under the head of the fibula; and (6) in the popliteal space. Dana also gives the back of the foot and the sciatic notch as points of tenderness. In some cases the pain is referred, and it is found in the area of distribution of the sciatic nerve (see figure). Bruce (502, p. 511) advances an original claim when he states that sciatica is due to disease of the hip joint. He has found wasting of the gluteal muscles (59 per cent.) and obliteration of the gluteal folds (30 per cent.) in nearly all the cases which he has examined. Lameness was also most constantly present. Diagnostic of sciatica is pain running up the back of the thigh when pressure is made on the posterior part of the knee with the leg extended a little more than a right angle (Dana, from Gowers). Kernig's sign is that hip motions are free as long as the knee is flexed, but become limited if the leg is straightened and flexion of the thigh is attempted. Sciatica should be diagnosed from hip-joint disease, disease of the cord (tumors of the cauda equina), new growths (sarcoma), bone formations, etc. Gordon (608) reports two cases of tumor of the sacrum which had been mistaken for sciatica. Tabes has sometimes been mistaken for sciatica, but the presence of the knee jerk in sciatica will exclude tabes. In relation to sciatica, Faber (616) mentions several cases, in which, in addition to the sciatica, there was also present a well-marked degree of adiposa dolorosa. After the reduction of the adipose

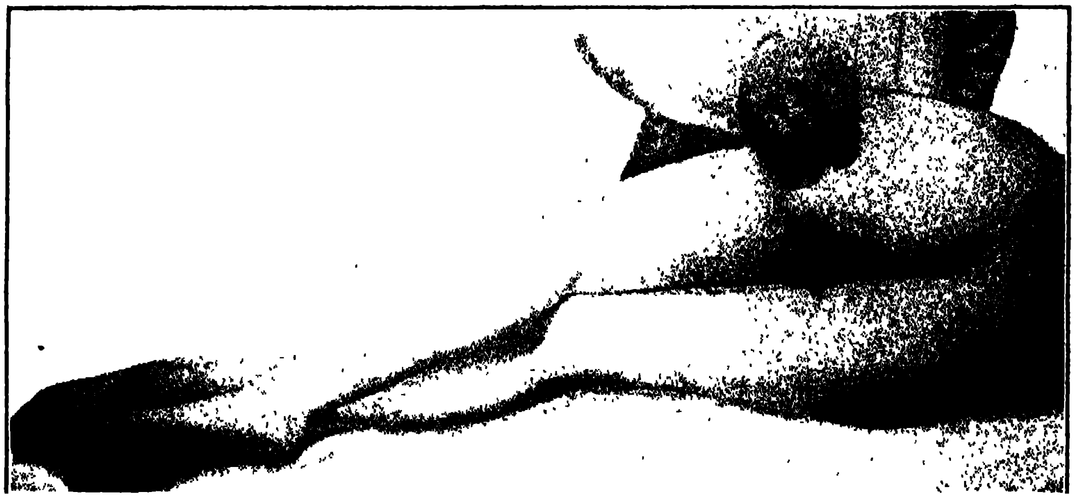

FIG. 57.—METHOD OF ELICITING PAIN IN SCIATICA.

tissue, the patients felt very much better. In cases of this kind, patients may have at the same time well-developed symptoms of both adiposa dolorosa and sciatica, and the one should not be treated to the exclusion of the other. In all cases of sciatica examine the pelvis carefully (per vagina and rectum) and the hip-joint both bimanually and by the X-ray.

In Figure 57 is shown a method of eliciting pain in sciatica by making pressure on the nerve as it emerges from the sciatic notch.

Plantar Neuralgia.—Plantar neuralgia is due to a lesion of the plantar nerve, and anesthesia or paresthesia frequently accompanies the pain. In the accompanying figure the area of distribution of the nerve is outlined, and it is in this area that the pain occurs.

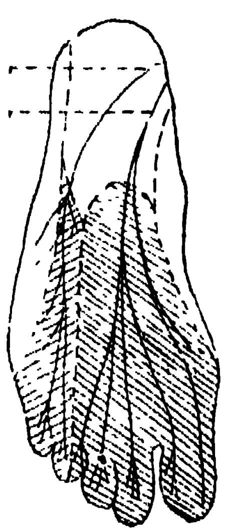

Fig. 58.—Distribution of the Plantar Nerves. The plantar nerves are branches of the tibial which is a branch of the sciatic (modified from Cunningham's Anatomy; also from Gerrish's Anatomy).

Morton's neuralgia, due to pressure on the digital branch of the external plantar nerve, is found in early stages of flat-foot disease.

In some cases of typhoid fever the toes become very tender. This, according to McCrae (607), is due to a local neuritis. It closely resembles a plantar neuralgia. The first complaint of the patient is of pain from pressure of the bed-clothes.

Sacral or Lumbar-cord Neuralgia.—Sacral or lumbar-cord neuralgia is betrayed by pain in practically the same regions as Head has outlined as the distribution areas of the different cord zones. In Kocher's figures the boundaries are, as a rule, held to be somewhat too high, the true areas in reality being one or two zones lower.

It is useless to reiterate what has been said in regard to lumbar or sacral root neuralgia, because the symptoms are exactly similar to those found in brachial root neuralgia, to which the reader is referred. With this reference, and by the aid of the accompanying figures (Head zones; and Figs. 1889, 1890, Toldt), the reader should be able clearly to differentiate this condition.

When a root or a root ganglion is involved, a continuous area of the skin is always affected, even though the fibers derived from this root unite with others to form a plexus. These regions of distribution overlap so that when a root is diseased, sensation (epicritic) is not completely destroyed over the entire area of the root distribution (Tigerstedt). It is entirely absent only in a central area. It increases gradually toward the periphery until it becomes normal in the areas of distribution of the unaffected roots. This border zone is not present, as a rule, for protopathic sensation. For this the cord zones seem to be more definitely marked. There is greater overlapping in the distribution of the nerve in the peripheral part of a limb than in the proximal part (Buzzard, "Brain," Vol. 25, p. 308). This is due to a spreading out of the nerve fibers in the periphery of the limb. These border areas react to a much greater degree than normal to painful stimuli, but the strength of the stimulus to produce a reaction must be much greater than that applied to normal skin.

In regard to loss of sensation, Head and Sherren say that "it would seem that division (disease) of the posterior roots abolishes sensation to prick over an area larger and more sharply defined than that which becomes insensitive to light touch. Moreover, this insensibility to prick is accompanied by an inability to appreciate temperatures below 15° C. and above 60° C., although 40° C. and 23° C. may appear definitely warm and cool." In lesions of the peripheral nerves the opposite is the case, the epicritic sensation being lost in a larger area than is the protopathic; i.e., the sensation to fine touch was absent in a larger area than was the sensation to prick (Head and Sherren, 244, pp. 310-311). Buzzard (613), in a case of injury to the cord roots, found the sensibility to pain and temperature abolished, but the tactile sensibility partially retained. When sensation returns, the first to recover is the sensibility to prick, and to the more extreme degrees of heat and cold (Head and Sherren). In some cases lesions of the posterior roots are present, and sensations are lost without the patient being aware of their absence.

When the posterior ganglia are affected, herpes generally accompanies the neuralgia. When it is present, a copious eruption of vesicles appears over the affected area. These, when they dry up and desquamate, leave a brownish spot. The pain does not disappear upon the disappearance of the eruption, but may continue for some time longer. A diagnostic sign of value in differentiating cord lesions from root or nerve lesions is the dissociation of sensation. When the cord is diseased, pain, touch, temperature, etc., may be individually or collectively abolished; but in nerve lesions they are always collectively abolished (Sherren, 612).

The following is a differential diagnosis, compiled chiefly from Sherren:

Cord Lesion.	Peripheral Lesion.
Loss of pain perception.	Pain produced by excessive pressure as long as there is any touch sensation.
Temperature sense is changed, so that (a) sensibility to heat may be abolished without any change in respect to the sensibility for cold (the inverse may be the case); (b) all distinctions between the minor and extreme degrees of temperature are lost; and (c) "insensitiveness may be present to all forms of heat and cold, the lightest touch may be felt, and discrimination of the points of a pain may be present."	All sensations are affected, but not to the same extent, the epicritic being affected in a greater area than is the protopathic sensibility.

CORD LESION.	PERIPHERAL LESION.
Both superficial and deep touch are usually unaffected, but when absent they usually disappear together.	Absent in a peripheral lesion.
The patient may have touch sensation, but be unable to appreciate pain, heat and cold.	"Light touches over the distribution area with cotton wool are usually not appreciated, though deep touch and pressure evoke a response."
Passive movement and position of the limb are not apparent to the patient.	Passive movements and position of the limb apparent.
Spasticity of muscles on the same side below the level of the lesion.	No spasticity.
Paralysis and wasting of muscles at level of the lesion.	Paralysis of the muscles supplied by the affected nerve.
Reflexes having origin below the level of the lesion are increased.	Reflexes originating in the affected area are decreased.
Pupillary reflex may be affected if the lesion is in the cervical cord, on account of affection of the cervical sympathetic.	Pupillary reflex is not affected.
Muscle atrophy may not occur.	Muscular atrophy of the muscles supplied by the affected nerve is always present.

CENTRAL NERVOUS SYSTEM[1]

The discussion of diseases of the central nervous system requires a recapitulation of the normal anatomical relations, which will be given, as briefly as possible, in the following paragraphs.

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[1] Written by Dr. Alfred Neuman, Vienna.

It will be entered upon here only so far as appears necessary for the understanding of the subject.

ANATOMY

The surface of the brain is supplied with furrows and convolutions, which, though of many varieties, show a certain regularity through which it is possible to differentiate them in every case. A few of them have special importance, and will be more minutely discussed.

The central convolutions on the convex side of the brain, the paracentral lobe, and the median wall of the hemisphere with the adjacent part of the frontal lobe, represent the motor region. Farthest below is the center for the facial and hypoglossus; in the middle is found the center or centers for the movements of the upper extremity; and in the uppermost third those for the movement of the lower extremity of the opposite side of the body. The centers innervating the musculature for the act of eating, for talking, for trunk movements, and for the closure of the eyes, are connected with the corresponding muscles of both sides, so that in case of a unilateral destruction of a center, the ability to perform these movements still persists. The speech center occupies the posterior part of the third frontal convolution, as well as the first temporal convolution. In right-handed individuals it lies in the left hemisphere. In the third frontal convolution occurs the transformation of ideas into words. The motor speech center in the temporal convolution is the seat for word sounds (sensory speech center). The centers for the sensation coming from the body lie, apparently, in the region of the motor centers, and, as it seems, are practically identical with them. However, the entire posterior central convolution, as well as the parietal lobe, evidently belongs to the sensory sphere. The centers for vision lie in the occipital lobes, viz., in the fissure calcarina and in the cuneus, perhaps, also, in the neighboring adjacent portions of the lingual globe. The recollections of sensations of sight (the field for optic memory) are said to lie on the convexity of the occipital lobe.

The olfactory center is supposed to lie in the gyrus hippocampus and uncinatus. The auditory center occupies the upper convolutions of the temporal lobe. From these centers, on the one hand, pass the centrifugally conducting fibers to the periphery; on the other hand the centripetal conducting fibers enter them. Of course, it is neither possible nor necessary to discuss all the conducting tracts; only the two most important ones will be discussed here.

Passing inward and downward from the motor centers, the motor fibers are gathered in the posterior limb of the internal capsule, near the knee. They pass then into the brain peduncle, and from here the central portion passes through the pons into the medulla oblongata, where a part undergoes decussation and enters the lateral column of the spinal cord, from whence it goes over into the anterior roots of the peripheral nerves. The smaller part, non-decussated, descends in the anterior column of the spinal cord, and undergoes partial decussation farther below, and finally enters the anterior roots.

The fibers for the motor nerves, which spring from regions lying adjacent to each other, run to the capsule in front of the pyramidal tract, decussate in the pons and in the medulla, and reach the corresponding nuclei.

The course of the sensory conducting fibers is more complicated, but it shows in many respects a resemblance to that of the pyramidal fibers. These sensory fibers, entering through the posterior roots, run for a part of the time (uncrossed) in the funiculus gracilis and cuneatus to their nuclei, also to the nucleus of the funiculus gracilis and the nucleus of the funiculi cuneati in the posterior surface of the fourth ventricle. From here they pass through the fibers of the arciformis internis, between the olives, to the opposite side (lemniscus decussation), which lies above the pyramidal decussation. One other part of the sensory fibers which ascends in the ground bundle of the anterior and lateral columns of the cord, and has previously crossed, joins with the first ones, after their crossing, and then again enters in common with them and passes through the crest of the peduncle to the brain cortex, on the way undergoing, in the optic thalamus, another interruption by relaying cells. Besides this, on the part of the lemniscus tract (the median), there is another portion, namely, the lateral lemniscus, which is composed of the fibers of the acousticus and the sensory fibers of the cranial nerves, and which lies more laterally. It also arises in the upper half of the pons, out of a collection of ganglia which communicate with the corresponding sensory cranial nerves, and passes, partly decussated, into the corpora quadrigemina, and from thence to the cortex.

The pains which are due to diseases of the nervous system or its sheath are localized, on the one hand, in the head, in affections of the brain, and on the other hand in the back and the extremities in diseases of the spinal cord. Exceptions to this general rule occur. Thus, there are pains radiating into the extremities in affections of the sensory tracts in the brain (Edinger) and headache in spinal-cord diseases (tabes, multiple sclerosis). Although these exceptions are not very frequent, yet we cannot attribute every headache to an affection of the brain substance, nor every back pain to an affection of the spinal cord. Both symptoms also belong to other diseased organs, and we are obliged to include in our discussion those forms of headache, or of pain in the back, which are caused by injuries which are indirectly elicited or produced by changes in the substance of the central nervous system or their sheaths (through the circulation or by reflex means); for instance, headache in anemia, constipation, abnormalities, or in refractive errors of the eye.

ORIGIN OF HEADACHE

Now we should first ask ourselves where the sensations designated as headaches arise, and in which tissue layer they are localized. It has been shown by clinical observations that both the brain substance and all its sheaths may be the seat of the pain; for instance, the outer skin, the aponeurotic layer of the cranial muscle, the skull with the periosteum, the meninges, and the brain itself. Concerning the membranes, it is seldom questioned that pains can originate therein; indeed, frequently they have been considered as the only bearers of headache, since they are supplied with cerebrospinal nerve fibers, which seem alone to be capable of pain conduction. The cortical origin of headaches, on the ground of the observations of Lennander, would be declared impossible, because of his observation, by operation, that the brain cortex may be sectioned without the patient feeling anything. Because of this, all intracranial headaches were attributed to irritation of the dura mater. Against this theory, Nothnagel objected that the mechanical irritation employed on the brain was not sufficient to produce a reaction because another sort of irritation (toxic, infectious) was needed to produce pain, as the headaches from poisoning, infectious diseases, and anemia prove. L. R. Muller remarks, further, that symptoms of loss of function which accompany migraine, as the shrinking of the field of vision, prove that certain parts of the brain are functionless for a short time. The observations of Oppenheim also speak in a very instructive way, opposing the view that only the dura mater can be looked upon as a source of pain, be it the result of direct or indirect irritation, through the intervention of brain pressure.

Before it can be certain that pain which is felt as headache may arise in the brain substance itself, we must know the nerves which conduct these painful stimuli to the cortex. The only peripheral nerves known to be present in the brain are of the sympathetic system. If it could be shown that these fibers are able to carry stimuli in a centripetal direction, we would be justified in ascribing to the brain substance itself the power of originating painful stimuli. The circumstances are similar in regard to the sensibility of the abdominal organs. Here, also, are found nerves, which, only with the vagus or with the sympathetic, enter into the viscera. To both, only the motor functions were ascribed, and therefore it was concluded that the viscera possess no special sensibility.

However, it has been demonstrated that the sympathetic nerves carry sensory fibers which convey irritations from the viscera to the central nervous system (Neuman); and this removes the most important objection to the acceptance of the idea that each organ possesses its own sensibility. The fact that the cerebral cortex is insensitive to the touch of the fingers, or of instruments, only goes to prove that it is insensitive save to these types of stimuli, which never occur normally. Just as the eye receptors act for light only, so there are probably receptors in the brain tissues which react only to special forms of stimuli. Just what these are is not as yet definitely known. The further conduction of the irritation may then be described as being through the rami communicans into the posterior roots and then through one of the above-described sensory tracts over the cord back again to the cortical brain substance. The conduction of the painful irritation from the coverings in diseases of the meninges, of the cranium, of the aponeuroses, or of the skin is over the trigeminus to the terminal cells of the same in the mid-brain; from there to the corpora quadrigemina, to the thalamus, and finally to the brain cortex; in a similar way, by the upper cervical nerves through the median portion of the lemniscus (Edinger).

Headache also appears as a symptom of disease of the brain substance and the meninges, and in diseases which certainly have nothing to do with these organs. As an example of the former may be mentioned the headaches of brain tumor or of meningitis; as an example of the latter, the so-called rheumatic or indurative headache may be mentioned. Not only have we to consider diseases of an organic nature, but also those in which purely chemical substances cause molecular alterations, and thus, perhaps, cause headaches. Uremia, the different metal poisonings, or the infectious diseases are examples. Here, also, belong the headaches of anemia, of congestive states, and possibly of migraine.[1]

In a similar manner, also, in the headaches of neurasthenia or of hysteria, we must think of a hitherto undemonstrated change in the central nervous system. The elicitation of pain through mighty efforts, irritation or fright, as well as some accompanying disturbances (for instance, dizziness), can hardly permit of another explanation.

If we would, with the help of headaches, try to arrive at a

[1] This as yet has not been demonstrated. For another view, see pp. 189 and 190.

diagnosis of diseases of the brain and its membranes, we must determine first whether they do not also occur in other diseases, and, second, whether they possess certain special peculiarities which would be characteristic of different diseases of the brain or of the brain membranes. Unfortunately, we have no such criteria. Neither are headaches limited to diseases of the central nervous system; nor are they of as many forms as their causes are numerous. One can certainly say that there is no form of headache which would be pathognomonic for a certain disease, with the single exception, possibly, of a luetic headache. We must not permit ourselves, in making a diagnosis, to be guided by the character of the headache alone, but must utilize the other symptoms. Nevertheless, in the character of the headache there are several peculiarities, which, if they do not speak for a certain disease, may still give a hint as to the nature of the trouble. Since, here, only those forms of head pain come into question which are connected, first of all, with diseases of the brain, or its membranes, all other kinds of pain belonging to the symptom complex of other diseases will be excluded.

Should headache be present, we must, in our diagnostic investigation, first search for disease of the outer coverings of the central organ; that is, of the bony skull, of the aponeurotic layer, of the scalp muscle, and of the scalp itself. These are treated in Chapter XIV. Should these be excluded the brain and its covering should next be examined.

HEADACHE IN DISEASE OF THE BRAIN AND MENINGES

Those diseases of the brain and the meninges in which headache forms an essential part of the symptom complex now will be described; and in conclusion an analysis of these headaches will be given.

First of all let us remember that not all pathological changes of the central nervous system are accompanied by pain, and gross lesions of the brain are found (post mortem) without the patient having complained of headache. Therefore, an extensive disturbance of the brain may occur, as in cerebral hemorrhage, without the patient making any complaint. Even laceration may occur so slowly that the patient either does not lose consciousness or does not at once become unconscious. The same is the case in brain-softening, in encephalitis, in infantile cerebral palsy, in general paresis, etc. Nevertheless, headaches are also found in the course of these diseases, either as a prodromal sign, as in hemorrhage, or in the later stages; but they are not characteristic of the disease.

In other diseases, however, headache forms an important symptom. Here must be included pachymeningitis interna, leptomeningitis, brain-abscess, brain tumor, aneurysm of brain arteries, syphilitic diseases of the brain and the meninges, migraine, neurasthenia, hysteria, and circulation disturbances in the brain. We shall not discuss the latter.

Pachymeningitis Interna Hæmorrhagica (*Hematoma of the Dura Mater*).—From a pathological, anatomical standpoint we have to deal with the formation of a fibrinous membrane on the inner surface of the dura mater, into which there occur from time to time smaller or larger hemorrhages. Headache may precede or follow a developing coma, or, if there is no coma, the pain in the head may be the chief symptom of the disease. It may be associated with nausea and vomiting. Generally the pain is very intense. It may be felt as a circumscribed area, and then sensitiveness to percussion, circumscribed, unilateral, or diffuse, is present. When the hematoma is located on the convexity, the pain on the diseased side frequently predominates. When the hematoma is localized at the base of the skull trigeminal neuralgia occurs, with other symptoms due to pressure upon the cranial nerves. The remaining symptom-picture of pachymeningitis is not at all characteristic. The etiology (alcoholism, infectious diseases, trauma, general paresis, senility, lues, and blood diseases, pernicious anemia, leukemia and scorbutus) is, above all, important. In classic cases an irritative stage, with delirium, precedes, and this is followed by the attack with coma, during which signs of increased brain pressure can be demonstrated. There are slowing and irregularity of the pulse, changed breathing, vomiting, contracted, sluggish or nonreacting pupils, choked disc, general cramps, bilateral deviation, etc. (see page 271).

Symptoms which depend upon the location of the hemorrhage are hemiplegias, monoplegias, and unilateral and disseminated twitchings. The gradual increase and frequent change of the phenomena, with remissions and recurrences, are considered a characteristic. Hyperidrosis and elevation of temperature to 41° C. (105.4° F.) frequently occur.

Leptomeningitis Purulenta.—Here there is an infiltration of the pia mater, especially on the convexity. This is at first serous and later purulent. There is also a serous infiltration of the superficial layers of the cortex. In the tuberculous form a gelatinous, rarely purulent exudate first spreads on the base between the brain and the peduncles and extends from here in all directions, especially in the sulci, reaching a marked degree, however, only on the convexity. Headache is so characteristic in this disorder that one should not make a positive diagnosis if headache is absent. It is extremely severe, mostly continuous, but paroxysmally increasing. The headache is, as a rule, located (by the patient) in the entire skull, sometimes more in the forehead or in the occiput. The patient manifests signs of pain, even in coma, in spite of the deepest stupor. He grasps his head, and at times cries out loudly, especially, however, if one tries to move the head.

In *tuberculous meningitis* the pain in the beginning has a different character. It occurs only temporarily, is not so great in intensity, and only later reaches the great severity just mentioned. Gradually there appear disturbances of the consciousness, delirium, and eventually coma. Stiffness of the neck (the head being drawn backward), stiffness of the muscles of the back, and boat-like retraction of the belly occur. Hyperesthesia of the skin and the muscles, restlessness, and jactitations are characteristic. Not uncommonly we find unilateral convulsions, and, less frequently, general ones. The patients conspicuously and rapidly become emaciated. In extensive involvement of the base of the brain, involvement of the cranial nerves occurs, the oculomotorius, the optic and also the acoustic being especially implicated. The fundus of the eye often shows the signs of neuritis. The tendon reflexes, which may be increased at first, are later usually lost, as are also the skin reflexes. Paralysis of the bladder and the rectum occurs only just preceding death.

Chronic Anemia of the Brain (Chlorosis, Pernicious Anemia, Leukemia, etc.).—The headache in these diseases is usually not very severe, often consisting only in hyperesthesia of the head. It can be recognized, sometimes, by the fact that it grows worse when the patient is in an upright position, and decreases when he lies down. Other signs due to anemia of the brain are the occurrence of fatigue, both mental and physical, after a small amount of work. Drowsiness, humming in the ears, stars before the eyes, vertigo, and an apathetic state may be present. All these conditions improve when the patient lies down (see page 272).

Hyperemia of the Brain. Congestions which consist of a sudden afflux of blood to the head cause pressure and sometimes pain, which increases with the pulse beat. Other symptoms consist of a feeling of heat, of throbbing in the face, vertigo, and disturbance of consciousness. These attacks, however, usually last only for a few minutes, sometimes an hour, and, in rare cases, several hours. The headache in venous congestions of the brain, ear lesions, struma, etc., is made worse by coughing and sneezing, as well as by the patient assuming the horizontal position, especially with the head drooping. The rest of the symptoms are not unlike those in chronic anemia, i.e., apathy, drowsiness, vertigo, and slight mental confusion.

Brain abscess originates from a suppuration transmitted from the skull. It may be of traumatic or otitic origin, or may arise from remote organs. In regard to the latter, a lung abscess, lung gangrene, or a pyemia may form the primary starting point. Headache is one of the earliest and most constant symptoms of brain abscess. It increases, especially during the development and the growth of the pus focus, to such a high degree that the patient constantly groans and behaves like a maniac. In the latent stage the pain may be slight. These paroxysms of pain often last only for a few hours; sometimes, however, they persist for days. The pain is of a boring, throbbing character, mostly dull, either spread over the whole head, or is more severe on one side, principally on that which is the seat of the abscess. However, the localization of the pain does not always correspond to that of the focus. An abscess of the cerebellum, for instance, may cause frontal headache. A circumscribed area of sensitiveness, on percussion, furnishes a much more important clew to the localization of the focus. Coughing, sneezing, stooping, as well as fever, make the headache worse. Other symptoms of brain abscess due to the suppuration, are elevation of temperature, which does not show any characteristic course, and the not very infrequent chill. Retardation or irregularity of the pulse, changed breathing, optic neuritis (which occurs here more frequently than choked disc, and, indeed, more frequently on the same side as the focus), general convulsions and mental disturbances, chiefly in form of stupor, depression, delirium, and eventually coma are later symptoms. Rapid emaciation is often very conspicuous.

Brain Tumor.—Headache is one of the most frequent signs of this disease. In accordance with the gradual growth of the tumor, the pain is moderate in the beginning and variable in its intensity. Later it becomes very severe, but still shows exacerbations, which occur generally in the morning. They may be partly spontaneous, and partly due to an increase of blood pressure from pressing, coughing, sneezing, stooping, etc. During such paroxysms the patient may either lie in bed, groaning, often perfectly apathetic, or he may run about in the room, pushing and knocking his head against the wall, and behaving like a maniac. Stupor that occurs in the later stage dims the severity; yet even then one observes that the expression of the face is distorted, and the seizing of the head by the hands proves the continuance of pain. The pain is, as a rule, diffused over the entire head; sometimes it is unilateral, more in the occipital, or more in the frontal region. Sometimes the localization depends upon the position of the tumor, as tumors of the posterior cranial fossa;

for the most part, cause occipital headache, which may radiate into the shoulders. One must, however, not depend upon this entirely. More stress should be laid upon the circumscribed sensitiveness on percussion, which, however, does not regularly occur, but only when the tumor lies quite superficial.

Trigeminal neuralgia, especially of the first branch, is observed in tumors of the chiasma, cerebello-pontine angle, and pons, and may later be followed by loss of function of the nerve. Signs of pressure on the optic nerve are rarely lacking. Papilledema (choked disc) is seldom missed. It may be absent in tumors of the central convolutions, and of the first and second frontal convolutions, but it is almost never present when foci are in the pons. Otherwise, however, choked disc, or its forerunner, optic neuritis, is one of the cardinal symptoms. It is mostly double sided, frequently more intense on the affected side. Not less important are the changes of intelligence and of the psyche. The patients think, speak and act more heavily. Soon they become stupid and drowsy. They fall asleep while they are still speaking, or in the midst of a meal. At such times they pass feces and urine involuntarily. Delusional ideas, ideas of persecution, and finally delirium may be present. Very frequently vomiting (of a cerebral type) occurs, with retardation of the pulse, which may here assume a high degree, and, after some time, usually passes into pulse acceleration (vagus paralysis). Giddiness is frequently complained of. It has not, however, been accompanied by rotatory nystagmus, which occurs principally in tumors of the cerebellum. Convulsions and loss of consciousness occur paroxysmally, together or separately. Parallel with these general symptoms are the so-called focal symptoms. By direct focal symptoms we mean those phenomena which are the result of pressure on that area of the brain in which the new growth develops.

Focal Symptoms of the Motor Region. —Here are found the results of irritation, paresthesias and spasms, which are followed later by paralysis. These three phenomena generally begin in one particular place, and then spread over the neighboring areas, for the most part in regular order (Jacksonian fits). The order in which the individual groups are affected is a regular one, and extends from center to center, beginning, for instance, in the right foot, and extending to the knee, hip, shoulder, elbow, hand, and distribution area of the facial nerve. Consciousness is intact, at first, and only later becomes cloudy in attacks of greater intensity and longer duration. Correct observation of the muscle groups initially involved is of importance for the localization of the tumor.

As a sequence of such a spasmodic seizure, but also unaccompanied by a seizure, paralyses arise, which, in the beginning, are transient, but which later become permanent, and attack (like cortical epilepsy), little by little, wider areas, until finally they present the complete picture of a hemiplegia, with all its characteristics, namely, increase of the tendon reflexes, spasms, absence of skin reflexes, Babinski, clonus, etc.

TUMORS OF THE FRONTAL LOBE produce motor aphasia if they lie in the left inferior frontal convolution. In tumors of the left second frontal convolution one sometimes sees, as a result of the disturbances of the innervation of the muscles of the buttock, uncertainty in walking and standing, and in turning toward the crossed side. As a remote effect upon the motor region, Jacksonian epilepsy may occur. When the tumor lies in the temporal lobe, disturbances of hearing, such as buzzing and whistling, may occur. There may, also, be disturbances of smell and taste. Finally, tumors of the left first temporal convolution produce word-deafness, memory aphasia and paraphasia. Here, as a distant result, are observed Jacksonian epilepsy; and further, from the action on the occipital lobe, crossed hemianopsia, hemianesthesia, and hemiplegia.

TUMORS OF THE PARIETAL LOBE give rise to little that is characteristic (disturbances of muscle sense, crossed hemiataxia). In fact, as a rule, they produce only distant effects, by pressure upon the motor region (Jacksonian spasms), or on the occipital (hemianopsia), etc.

Still more uncertain is the diagnosis of TUMORS OF THE CORPUS CALLOSUM, which, according to Ziehen, have paraparesis as the only sign of any value. Apraxia is often present in tumors of this region.

TUMORS OF THE CENTRAL GANGLION characterize themselves by disturbance of the inner capsule. Therefore, they cause hemiplegia, which gradually arises if more of the anterior part of the capsule is affected, and hemianesthesia if more of the posterior part is affected. Hemichoreas, hemianesthesiæ, and unilateral tremors may result.

When the CORPORA QUADRIGEMINA are the seat of the tumor, sight disturbances, hearing disturbances, and double-sided paralysis of the eye muscles of a muscular character form the clinical picture. With the disease, also, come disturbances of equilibrium on walking and on standing.

TUMORS OF THE PEDUNCULI CEREBRI produce paralysis of the oculomotor of the same side, and of the extremities of the opposite side (hemiplegia alterans superior), oculomotor paralysis, with tremor, similar to that in paralysis agitans.

If the CEREBELLUM is the seat of the tumor, this can be recognized, in most cases, by a few important signs. The most characteristic is cerebellar ataxia. The patient sways from one side to the other. Frequently, also, he complains of a genuine dizziness, in which objects seem to be moving around him, especially upon sitting up. With this dizziness nystagmus is frequently combined. Vomiting is very common. It is also an important symptom that the headache is localized, especially in the occipital region, possible in the nape of the neck, and that the choked disc, which is mostly bilateral, is seldom absent. Along with this are opisthotonic and tetanic contraction of the musculature of the neck. As indirect local symptoms, the affections of the different cranial nerves, of the pyramidal tract (paraparesis, crossed hemiparesis, intentional tremor) and also the occurrence of hydrocephalus interna must be considered.

TUMORS OF THE PONS show slight development of general symptoms, and the absence of a choked disc almost as the rule. The most classic symptom is the hemiplegia alterans inferior. There is paralysis of the extremities of one side, with paralysis of the facial, trigeminus, or abducens, of the other side, in which case, of course, all three of the above-mentioned cranial nerves may be affected. Very frequently, before the paralysis, very severe attacks of trigeminal neuralgia occur. Further, associated eye-muscle paralysis of the right rectus internus on the side of the tumor must be mentioned; also in right-sided paralysis there is a simultaneous disturbance of hearing, through pressure on the acoustic nerve at its place of origin.

TUMORS OF THE MEDULLA may run a symptomless course, but when they produce symptoms they are similar to those of tumors of the pons, with the exception that they injure deeper-lying cranial nerves, namely, the eighth and twelfth, causing disturbances of hearing, speech and deglutition, as well as paralysis of the extremity on the other side, singultus, diabetes insipidus, breathing changes, etc.

If the tumor is seated in the THIRD VENTRICLE, drowsiness and change of intelligence are usually prominent.

TUMORS OF THE BASE OF THE BRAIN give rise to few general symptoms. According to Oppenheim, choked disc and vomiting frequently fail. Pain, on pressure, occurs in the bones which are in relation to the base of the brain. Bleeding from the nose and pharyngeal cavities also occurs; and, above all, is to be considered the involvement of brain nerves in a certain combination corresponding to their topographical arrangement.

TUMORS OF THE HYPOPHYSIS also produce few general symptoms. Here, also, choked disc is frequently absent, and headache may be very slight. On the other hand, the eye symptoms (bitemporal hemianopsia, amaurosis, eye-muscle paralysis, exophthalmos) and certain disturbances in development (hypoplasia of the genitalia, feminine habitus), as well as adipositus universalis and myxedematous skin, form the most striking symptoms.

TUMORS OF THE POSTERIOR CRANIAL FOSSA often begin with humming in the ears, difficult hearing and disturbances of equilibrium. Associated with these is irritation or paralysis of the trigeminus, with absence of the corneal reflex (Oppenheim). In relation to this, as a result of the pressure on the surrounding region, cerebellar ataxia, nystagmus and sight paralysis (Oppenheim) occur. The patient complains of occipital and frontal headache and vomiting. Objectively, one very frequently finds choked disc and localized sensibility on percussion.

Aneurysm of the Brain Arteries.—Here the headache is also one of the general symptoms. It is generally described as throbbing, and may be half-sided, as in hemicrania, diffuse, or be felt more in the occiput (in aneurysm of the basilar artery). Vomiting, dizziness and stupor (corresponding to the reduction of brain space) are present, while, on the contrary, choked disc is infrequent. A pulsating vessel murmur, heard over the skull, is considered an especially characteristic symptom. However, this is found in other diseases, and also in normal children. The development of the process is often very rapid. The localization is to be inferred from the local symptoms.

Parasites of the Brain (*Cysticercus Cerebri*).—Headache, with dizziness, is a frequent symptom; but the characteristic signs are localized attacks of cramps, due to the location of the cysticercus in a circumscribed area of the motor region. Attacks of an epileptiform character, with psychic disturbances (imbecility, confusion, irritability), are present. The local symptoms differ according to the seat of the parasite. Frequently there is a conspicuous change in the intensity of the clinical symptoms. A cysticercus tumor may be diagnosed if the possibility of infection has existed (association with infected individuals, ingestion of raw pork, etc.), or if the cysticerci are found in another portion of the body. The echinococcus also produces tumor phenomena. However, it is very seldom that one can successfully diagnose it, since, in order to do this, an echinococcus cyst must be found somewhere else in the body.

Hydrocephalus Internus.—Headache, in this case, is usually constant. For the rest, the disease picture is similar to that of meningitis purulenta, with the exceptions that the fever is not so high, the headache is less severe, and frequently a perfect cure occurs, with sequelæ of eye disturbances. The differentiation is easiest made through spinal puncture. Chronic hydrocephalus progresses, in most instances, under the symptom-complex of a brain tumor, or a tumor of the cerebellum. According to Oppenheim, two points for the differential diagnosis are to be taken into consideration: (1) whether there exists a deficient congenital development (abnormal size and form of the skull); and (2) the occurrence of remissions or of intermissions of a month's or of a year's duration.

Syphilis of the Brain.—Anatomically the process consists either in the formation of tumor-like gummata or in changes of the vessel walls, especially of the basilar artery. A tubercular basilar, gummatous meningitis, starting in the region of the chiasm, is even more frequent. Headache is one of the earliest symptoms. It may occur months or years before other signs. Nightly exacerbations, recurring at a certain hour, and disappearing at a certain time, are characteristic During the exacerbation the patient suffers considerably by reason of the severity of the pains. In the intervals, however, the pain is bearable. It is mostly felt as a diffuse pain, situated deep within the skull. Sometimes it has a circumscribed border, if the process reaches the convexity. In these cases, also, a circumscribed percussion sensibility may be present. Other constitutional symptoms belong to the picture of cerebral lues; for instance, vomiting, dizziness, attacks of unconsciousness, psychic disturbances, dementia, stupor and states of irritability occur in a paroxysmal manner, alternating with periods of normal consciousness. In addition to these, there is paresis or paralysis of the cranial nerves, especially the optic, and oculomotor-ptosis is especially frequent. Any of the other cranial nerves may be involved in differing combinations. The repeated change in the intensity and the final complete disappearance of all the symptoms are typical. The onset of hemiplegia, which develops in the course of one or two days without disturbances of consciousness, is a frequent symptom.

Hysteria.--The headache, frequently felt as a dull pressure in the entire area of the skull, may often be localized to a circumscribed place on the vortex, in the occiput, or in the temple. It is, as a rule, associated with hyperesthesia of the scalp, so that the slightest touch or the least disturbance of the hair causes a pain which increases on pressure. Bodily and mental exertion and emotion may also produce increased irritation. The condition is improved by diverting occupations and during quiet and darkness. It may last for hours, days or months, and does not leave the patient even during sleep. The remaining hysterical symptoms are of so many forms that they cannot briefly be given here.

Neurasthenia. Here, also, the intensity of the headache is not very great. It appears mostly as pressure and constriction of the entire head, the feeling often being strongest in the region of the forehead, and not seldom in the occiput The patient also complains of a contraction, as though the head were bound with an iron band. The headache of neurasthenia is also produced or increased through great bodily or psychic irritation, or by emotions.

Hemicranic Headache (*Migraine*). —The real attack of headache is often preceded by symptoms which bear a certain relationship to it. Some patients, previous to the attack, feel languid, exhausted, and are without appetite, or, on the contrary, manifest great hunger. As aura, Moebius designates certain paresthesias, which may or may not precede the attack, namely, eye symptoms, flying bodies, glittering, narrowing of the field of vision (especially hemianoptic), and glistening scotomata; these may occur, for instance, as a light point in one or both eyes, which is diffused or travels across the field of vision in a zigzag line. Other forms of the aura are unilateral paresthesia, aphasia, confusion, states of anxiety, etc. The attack itself consists in headache of the severest degree. Generally it occurs after waking, with slight intensity, and gradually increases to an unbearable degree. It lasts for a few hours to a few days. Frequently it stops during sleep. There are patients in whom migraine attacks are of slight severity, and in whom light and severe paroxysms interchange. In the intervals, which may last for weeks and months, the patient feels perfectly well. The pain is mostly one sided, but is also double-sided, usually in the forehead and eye region. Less frequently the occipital region is attacked. As a rule, the pain is located by the patient as deep in the skull, and is of a boring or tearing character. The patient may say he feels as though his head were in a vise, as though it were bursting asunder, or as though it were being belabored with a hammer. The countenance of the patient during the attack is, in most cases, pale, although in some instances the face and conjunctiva are reddened. During the attack, also, the patient is very sensitive to all forms of stimuli. Noises, smells and lights increase the pain. Nausea and vomiting sometimes are accompanying symptoms, and, in most cases, the attack concludes with them.

DIAGNOSIS OF HEADACHE IN DISEASES OF THE BRAIN AND MENINGES

The character of the headache alone rarely permits an accurate diagnosis to be made. Yet each and every one of the cranial lesions enumerated have some features which predominate more or less. Thus, in cerebral lues, our attention is drawn to the night attacks. This is rare in other forms of brain disorder.

Intensity. The intensity of the pain varies greatly in different cases. The severest degrees of headache are most frequently observed in leptomeningitis, then in brain-tumors, in abscess, brain-syphilis and hemicrania. Tolerable, though still severe, headache is found in pachymeningitis hæmorrhagica interna, in some forms of headache in hysteria, and in aneurysm of the basilar artery. Headache due to neurasthenia and disturbances in the circulation of the brain is naturally not very severe. In the first-named group of cases (pachymeningitis interna hæmorrhagica) paroxysmal exacerbations occur, giving rise to very conspicuous manifestations of pain. The patient groans, whines, and either shows dull apathy or jumps out of bed, runs about and presses his head. Pain of this severity, however, is only temporary, and the very manner of its occurrence, as well as the character of the free intervals, is important for the diagnosis in some cases.

It has been noted that the paroxysms of pain in cerebral syphilis may be expected with great probability during the night, The pain appears at a certain hour after the patient has gone to bed, usually at the same hour every night. In the periods between the paroxysms the headache is either of little intensity or disappears entirely.

The typical form of hemicrania is also characterized by its paroxysmal occurrence. After an aura of short duration, or perhaps without an aura, there appears the most severe pain, compelling the patient to lie down and keep absolutely quiet. Usually sleep puts an end to the attack, but frequently the pain appears in the morning after awaking. In this point, therefore, the pain differs from that in lues cerebri. Another feature may be used for the diagnosis of hemicrania, namely, that the pauses between paroxysms, which may last for days, weeks, even months, are perfectly free of pain. During these periods the patient feels absolutely well.

Paroxysmal exacerbations occur in other affections; for instance, purulent leptomeningitis, abscess, tumor, etc. These exacerbations, however, appear irregularly, and the periods between the paroxysms are by no means free from pain. It is important to know that in cases of brain abscess the paroxysmal exacerbations of the headache appear usually during the development and growth of the pus foci; and, obviously, for this reason they are frequently connected with fever-elevations.

Between the varieties of headache characterized by their great intensity and the headache which is described by the patient as hyperesthesia of the head (pressure or heaviness) there are scarcely any intermediate forms. The latter sort of headache is seen in neurasthenia, hysteria, and disturbances of circulation in the brain. It is characterized in most cases by its continuous course; although variations in intensity may occur, they do not show any feature characteristic of the condition. In most cases direct spontaneous paroxysms of pain do not occur, neither are there any periods perfectly free from pain; yet the feeling of pressure in the head does not leave the patient, even in his sleep.

Moderate degrees of headache occur in pachymeningitis interna, prior to, or after a comatose attack, and also without any coma. Here, also, there are intermissions of pain of varying duration, which cease on the onset of another bleeding. The headache in aneurysm and the paroxysms of headache in hysteria, which, as a rule, occur in the parietal region, are somewhat similar to those in pachymeningitis, so far as their intensity is concerned.

Localization of Pain.—Localization gives but few clews for diagnosis. True, there are diffuse headaches, unilateral headaches, headaches involving only the frontal region, as well as those of the occipital region. Finally a headache may have a circumscribed area; but there is scarcely one of those localizations which might be looked upon as characteristic of any definite affection. Not infrequently one finds all of these localizations involved in one and the same disorder This may be the case in a brain tumor, for instance. Nevertheless, some affections predilect a certain region of the cranium. We know, for instance, that in migraine headache occurs most frequently *unilaterally*. Moebius states that among patients of his from whom he could obtain reliable statements fifty seven had almost constantly unilateral headache, whereas twenty-five declared that they had felt it on both sides. Moebius doubts the reliability of the second statement. On the other hand, there are diseases in which unilateral headache is, comparatively speaking, seldom present, for instance, in leptomeningitis, neurasthenia and in disturbance of the cerebral circulation. *Frontal* headache is observed in neurasthenia comparatively frequently, and the unilateral headache in migraine is often most intensely felt in or behind the eye. *Pressure in the parietal region* is frequently met with in hysteria, is mostly circumscribed and is accompanied by sensitiveness on pressure. In a comparatively large number of diseases the painful area is sharply circumscribed, a fact often noted in pachymeningitis, in brain abscess and in cerebral syphilis. This circumscribed pain is generally, also, associated with a circumscribed sensitiveness on pressure (the so-called sensitiveness on percussion).

The tension of the pain helps less frequently than its localization in making a diagnosis. Certainly even here the greatest caution is necessary; for cases in which a tumor in the occipital region causes frontal headache are by no means rare; and it also happens that a tumor of the left side may give rise to pain felt in the right half of the cranium. If, however, a pain is constantly felt in one place, or, when generally diffused, it originates from one place, no mistake will be made if one locates the cause of the disease, be it a tumor or an abscess, in that region. Pain in the occiput or neck, radiating into the back, justifies one in assuming that the focus lies below the tentorium. We may assume, with great probability, that a lesion exists in the same area in which pain is present, if we have to deal with a pain constantly confined to one side, or to the frontal region. Of course one should strictly avoid depending upon pain, alone, in forming conclusions. To form a diagnosis, which often implies a great responsibility, all the other observations and examinations (which will be discussed later) must be resorted to.

Character of the Pain.—The character of the headache tells us very little concerning its cause. Patients describe various kinds of headache in quite different ways, most frequently as dull, pressing, drawing, cutting, lancinating, constricting, driving asunder, roaring, pulsating, and throbbing. Since every form may occur, in very different intensities, there result an exceedingly large number which are of only very little value for the diagnosis. If there is a kind of headache to which we may ascribe a characteristic feature, it is the pulsating and throbbing variety. It is found most clearly pronounced in an aneurysm of the cerebral vessels, but also in hyperemia, and sometimes in cases of abscess.

A knowledge of those external influences which may cause an exacerbation of an already existing headache, or which are capable of producing headache, is more important for the diagnosis than are the location and the character of the pain. It has been emphasized that, in those affections in which the sensitive area is circumscribed, an increase of the headache can be brought about on pressure, with the finger, or by striking with the percussion hammer. These affections are pachymeningitis, brain abscess, cerebral syphilis and hysteria. There are other cases in which the headache grows considerably worse by the increase of internal brain pressure, such as occurs in coughing, sneezing, pressing, stooping. This is the case in brain abscess, brain tumor, and passive congestion. Sometimes movement of the head increases the headache, especially in meningitis and migraine.

In the latter, according to Moebius, movements of the eye have a much more unfavorable effect than those of the whole head. The upright position of the body has an unfavorable influence upon anemic headache, whereas horizontal position increases an hyperemic headache. Headache due to abscess, tumor and hemicrania may be increased by alcoholism. In conclusion, it may be added that mental exertions and emotions are able to elicit and to increase headache in neurasthenia, hysteria and hemicrania, and the same factors may aggravate the headache in case of tumor.

Influence of Therapy.—Diverting occupation, eating, and rest influence headache in a favorable way, especially nervous and hysterical headache. According to Moebius, however, they may alleviate, also, less severe attacks of migraine. This latter often may be cured or alleviated, without any other treatment, by removal of irritants (light, noise, etc.).

By the observation of these circumstances, it will often be possible to draw, from the character of the headache, a conclusion as to its cause. A severe pain, for instance, which appears paroxysmally on one side, and which is favorably influenced by rest and ends with vomiting, may be looked upon with great probability as hemicrania; nightly exacerbations point to cerebral lues, whereas headache that occupies the cortex makes us think first of hysteria. It is not the task of the diagnostician, however, to make the diagnosis from one single symptom, but eventually he will utilize, in making the diagnosis, all the signs of the disease. In the following lines, therefore, we will discuss all those factors by which the individual affections of the brain and spinal cord may be differentiated; and for the sake of completeness those affections will be discussed here which are not accompanied by pain.

DIFFERENTIAL DIAGNOSIS

Brain Abscess.—If the analysis of the pain has shown that we have to deal with a brain abscess, the following conditions will come into consideration for the differential diagnosis:

BRAIN TUMOR.—Against this would speak the etiology (with the exception of traumatism, which also may cause a tumor), the fever, the chills, and the comparatively more rapid course (weeks to months). A well-marked, choked disc (optic neuritis occurs also in an abscess), as well as the better-marked phenomena of pressure, in general, would indicate tumor.

LEPTOMENINGITIS PURULENTA.—This takes a course even more rapid than abscess—days and weeks. It shows high fever and acceleration of the pulse (in case of abscess only low grades are observed), hyperesthesia of the organs of sense, of the skin and muscles, involvement of the cranial nerves, scaphoid retraction of the abdomen, and rigidity of the muscles; whereas optic neuritis, retardation of the pulse, less stupor and a negative result of lumbar puncture, i.e., a clear puncture fluid, rather speak in favor of a diagnosis of brain abscess.

LEPTOMENINGITIS SEROSA.—This occurs either as a primary affection, or as an accompanying symptom of an otitis media. It may heal spontaneously. In addition to this, the greater frequency of a choked disc and of disturbances of sight would speak against brain abscess.

OTITIS MEDIA.—This may cause diagnostic difficulties by the occurrence of cerebral symptoms, but can be recognized by the disappearance of the latter on removal of the pus.

EXTRADURAL ABSCESS (*In Sequence to a Suppuration of the Ear*).—This is indicated by the presence of focal symptoms and the absence of local signs, i.e., the absence of the inflammatory swelling and painfulness in the region of the mastoid process.

SINUS THROMBOSIS.—Here are found, in contradistinction to brain abscess, pyemic fever and acceleration of the pulse, complete absence of any disturbance of consciousness, more frequent occurrence of choked disc, and externally a thrombosis of the jugular vein in the neck. On the other hand, focal symptoms speak for the presence of an abscess.

HEMORRHAGES INTO THE MENINGES.—When caused by traumatism, they proceed without any fever, and follow directly after the injury.

MIGRAINE.—Against it speak both etiology and absence of fever.

TRAUMATIC NEUROSES, HYSTERIA AND NEURASTHENIA.—They may occur as concomitant symptoms of a brain syndrome, or may be independent affections, and only simulate these.

BRAIN SYPHILIS.—This is mostly accompanied by the loss of pupillary reaction to light, and can be surely diagnosed by the positive result of Wassermann's reaction and of antiluetic treatment.

Leptomeningitis.—In the differential diagnosis of leptomeningitis quite a number of diseases come into consideration in which focal symptoms always decide in favor of meningitis.

PNEUMONIA, TYPHOID FEVER AND PYEMIA.—Rusty sputum and dullness over the lungs speak for pneumonia; gradual development and the positive result of Gruber-Widal's reaction speak for typhoid fever; retardation of the pulse, stiff neck and paralysis of the cranial nerves, as well as the intense headache, continuing also during the coma, speak for meningitis; frequent chills, skin and rectal bleeding, and joint swelling speak for pyemic condition.

BRAIN HEMORRHAGES, EMBOLUS AND THROMBOSIS, as well as ENCEPHALITIS HEMORRHAGICA never cause fever-elevations of such a duration as seen in meningitis.

OTITIS MEDIA is confused with meningitis principally because the ear trouble is followed by a serous leptomeningitis. As such a serous meningitis often can be differentiated from a purulent one only with difficulty, a differential diagnosis can be made in most cases only by the disappearance of the meningeal symptoms after the evacuation of the otitic focus.

In uremia, albumin and formed elements, as a rule, are found in the urine.

The SEROUS form of MENINGITIS is, as above mentioned, difficult to differentiate from the purulent form. In most cases the fever is less.

DELIRIUM TREMENS.— Stiff neck and the extremely severe headache speak against it.

TUBERCULOUS MENINGITIS occurs in early childhood (2 to 14 years). It does not set in in such an abrupt manner, and shows frequent remissions (of temperature, stupor, etc.).

In children the STOMACH and INTESTINAL DISTURBANCES may cause symptoms similar to those of leptomeningitis, and may give rise to confusion in diagnosis. However, the influence of the diet and the action of a purgative will soon clear the diagnosis.

Brain Tumor.- HYSTERIA may be differentiated by its headache, spasmodic attacks and hemiplegic paralysis. Choked disc and focal symptoms will guide us here, but it must not be forgotten that both affections may occur together. The possibility of influencing the condition psychically speaks for hysteria. In case of a tumor we find also, during the acme of the pain, retardation of the pulse and vomiting. These are found in hysterical headache, only when it occurs on one side.

Concerning MIGRAINE, which might give rise to confusion by the severity of the headache and vomiting, we must be guided by the history (heredity in migraine) and by the presence of choked disc and focal symptoms in tumor of the brain.

PARESIS often comes into review in the diagnosis of brain tumor. The clinical symptoms may be very similar. A positive Wassermann, a positive cell count, and a positive globulin reaction almost certainly speak for paresis and against a brain tumor. In paresis choked discs are not frequent. The attacks of cortical epilepsy occurring in both, and which in the external manifestations are similar, usually leave little permanent palsy in paresis.

MULTIPLE SCLEROSIS comes into consideration in affections of the cerebellum, of the pons, and of the corpora quadrigemina, which likewise produce intention tremors, nystagmus, spastic ataxia, as well as paretic symptoms in the extremities. To these must be added the occurrence of atrophy of the optic nerve, if they are accompanied by brain symptoms. However, the general symptoms of the tumor, such as severe, continuous headache, the retardation of the pulse, vomiting and stupor, do not belong to the clinical picture of multiple sclerosis. In epilepsy, which has a certain similarity to tumor in its paroxysmal character, the general symptoms will facilitate the differential diagnosis.

Pachymeningitis Hæmorrhagica Interna.—Differential diagnostic points speaking against pachymeningitis are either the entire absence of stiff neck or the presence of a slightly stiff neck, as well as the rare involvement of the basal cranial nerves; however, both signs occur also in pachymeningitis, if it is located at the base of the brain.

CEREBRAL HEMORRHAGE frequently is with difficulty differentiated from pachymeningitis. The absence of the above-described symptoms would lead to a consideration of a hemorrhage into the brain substance; and the change of symptoms, the choked disc and the intercurrent appearance of convulsions to that of pachymeningitis.

In EMBOLISM and THROMBOSIS elevation of temperature is rare in the later stages, and phenomena of brain pressure are absent.

MIGRAINE may also come into question in the basal form of pachymeningitis. Inherited predisposition, as well as a rapid course without fever, speaks for migraine.

THALAMIC PAINS AND THE THALAMIC FUNCTIONS[1]

While central pains, probably due to lesions in and about the basal ganglia, were first suspected by Nothnagel, it is chiefly to the studies of Dejerine and Roussy that we are indebted for the clearing up of the question of pains due to lesions of this region.

Dejerine and his students have shown that lesions of the thalamus, especially of certain of its nuclei, produce a charactertatic picture, the thalamic syndrome (Jelliffe), in which severe and persistent pains form a prominent part.

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[1] Written by Dr. Smith Ely Jelliffe, New York, U. S. A.

These pains usually involve the side of the body on which the lesion takes place, and are noted for their severity, their persistency, and their resistance to analgesics.

The entire picture of the thalamic syndrome is so characteristic that its somewhat at first sight anomalous symptoms should be given in detail. This is all the more important since many patients with the thalamic syndrome are thought to be malingerers or hysterical.

The usual thalamic syndrome begins, as a rule, with a mild apoplectiform attack. It may be severe, or it may be so mild as to escape ordinary observation. After a certain length of time, the motor weakness of the early slight or severe hemiplegia disappears entirely, or to a greater or less extent. The patient has some difficulty in managing his hand and leg, and it appears to be different from the hand of the well side. Then pains are felt on the affected side. They may at first have been only uncomfortable sensations in the skin of the side; they usually take the form of acute shooting pains, and may be in the entire half of the body, or may be limited to the face, to the upper extremity, or to the lower limbs. They rarely cross the middle line, although in double thalamic lesions both sides of the body show painful distributions.

The nerve trunks are absolutely painless; they are not swollen, and careful search for Valleix's or Trousseau's points is unavailing. There is nothing to point to a neuralgic or a neuritic process.

These pains stab and jump and throb, and are complained of as excruciating. The ordinary analgesics do not touch them; even morphin is unavailing, at times, in checking their severity.

Notwithstanding these severe pains, it may be that careful sensory examination shows that the patient is unable to distinguish pain at all. This anomalous condition is further complicated by the fact that a pin prick which cannot be recognized as a pin prick, the patient being unable to tell the difference between the head and the point of a pin, is nevertheless felt as a disagreeable sensation. Here, then, is the apparent absurdity of a patient who cannot tell pain, yet has a disagreeable sensation when pinched, still suffering excruciating pain. Not only may the patient be unable to tell a pin point from a pin head, but he cannot recognize the difference between heat and cold, and burning sensations, recognized on the sound side, are translated as discomfort only on the thalamic side. He also loses superficial sensibility. The touch of cotton wool is lost. Furthermore, these patients have lost their deep sensibility. The position sense is gone, and they fail to recognize objects placed in the hand. The roughness of a lump of sugar may be interpreted as a disagreeable sensation, but is not recognized as roughness.

Moreover, these patients show slight motor incoördination in the hand or leg; they are ataxic, and more or less choreiform or athetoid-like movements are present in the afflicted side.

In some patients there are residual signs of a hemiplegia; slight spasticity, perhaps; slight clumsiness, increased radius-periosteal reflexes, triceps reflexes; perhaps lost abdominal reflexes on that same side; increased patellar reflex, a clonus and exaggerated Achilles jerks. A Babinski extension of the great toe is often absent, but may be present. Chaddoch, Gordon and Oppenheim's signs vary considerably. The motor synergistic phenomena, described by Babinski, Grasset, and Hoover, are all apt to be present.

One feature of special moment found in thalamic lesions and which has been emphasized by Head and Holmes is an excessive response to affective stimuli and the change in behavior in states of emotion of the abnormal half of the body. Thus, in many cases of pure thalamic lesion, if a pin be lightly dragged across the face or trunk, from the sound to the affected side, the patient exhibits intense discomfort when it passes the middle line. He not only complains that it hurts him more, but the face may become contorted. Notwithstanding this, he is unable to tell the difference between the point and the head of the pin. The same type of over-response is found to other forms of stimuli. Thus deep pressure, which cannot be measured at all, also evokes an over-response; the same is true for extremes of heat and cold, in spite of the fact that the patient is unable to distinguish between them. Visceral sensibility, scraping, roughness, vibration and tickling all show this over-response in the affected side.

Not only are painful stimuli over-reacted to, but pleasurable stimuli occasion a like over-response. Furthermore, in states of emotion, there may be different manifestations on the two sides of the body, just as painful and pleasurable stimuli may produce a stronger reaction on the affected side Thus some patients cannot hear music without its causing sensations in the affected side, or even causing motor unrest, movements of the leg with shaking. The choreiform movements, which are notable motor features, under the influence of emotional stimuli may be markedly increased.

From this it can readily be seen that the thalamic syndrome is a most important clinical picture, and that its more careful study is bound to throw considerable light upon the whole question, not only upon the subject of pain perception, but also upon emotional attitudes to all forms of stimuli. In fact, it opens the way to the most important of all of the questions taken up in this book. Through the study of the thalamus the entire sensory side of the human organism will be revealed, and it may readily be seen that sensory neurology will be the neurology and possibly the psychiatry of the next decade.

Thus far the study of the thalamus has shown that it contains the terminations of all of the secondary sensory paths. In it sensory impulses of every kind are regrouped and again redistributed. This redistribution takes place not only within the thalamus itself, giving us thalamo thalamic paths, but it also goes to the cortex in a fairly large series of thalamo-cortical paths. The thalamo-thalamic paths seem to pass to important centers, constituting what Head and Holmes have termed the "essential organ" of the thalamus which forms the main center for certain fundamental elements of sensation. It is a center which is complementary in function to the sensory cortex, and has distinct though related functions. The lateral part of the thalamus contains the cortico-thalamic paths through which the cortex influences the essential center, controlling and checking its activity. Analogous, in a way, is the activity of the motor cortex upon the anterior horn nuclei of the medulla and spinal cord. The excessive response to affective stimuli, pain as well as others, is due to a removal of this cortical control, just as an excessive motor reflex reaction recurs when the pyramidal tract does not bring down cortical stimuli from the motor area.

The activity of the thalamic center is of special import in our study of pain, for it has been pointed out that in lateral thalamic lesions there is an actual overloading of sensation with feeling tone.

The pains and paresthesiæ, found in many thalamic cases, have been thought to arise from "irritative" lesions, but this is probably not so. It would seem that the thalamic center is a true center for perception of sensations, including pain, and that the cortex has a definite relationship to these, so that it may modify the affective response and naturally, thereby, the motor responses. The essential thalamic organ is a center for conscious perception for certain elements of sensation. It responds to those stimuli which are capable of evoking pleasure and discomfort or consciousness of a change in state. The feeling tone of the body, which has often been termed the somatic or visceral tone sensation, is a thalamic function.

What the interrelations between the thalamus and the cortex are, so far as sensation is concerned, need not detain us at this point. We have chosen to isolate, for the purposes of our treatise, that sensation known as pain, therefore a discussion of the whole question would be somewhat out of place. Yet, a word should be added as to the cortical function in sensation.

The sensory cortex permits a concentration of attention on any part of the body which is stimulated. Such stimuli are passing through sensory paths to the thalamus. Many of low threshold value pass to the cortex or are automatically taken care of by the thalamus. Those of high threshold value pass into the essential organ of the thalamus and into consciousness, where they bring about a tendency to excessive reactivity, just as the anterior horn cells of the cord react excessively if uncontrolled. The sensory cortex gives a quick reacting mechanism to dampen down the affective response to thalamic over-activity.

This leads us to an interesting deduction made by Head and Holmes, in the study herein freely made use of, that the aim of human evolution is the domination of feeling and instinct by discriminative mental activities. This struggle on the highest plane of mental life is begun at the lowest afferent level, and the issues become more sharply outlined the nearer sensory impulses approach the field of consciousness.

In the accompanying table an attempt is made to simplify the diagnosis between a cerebral (sensory) cortex lesion and one of the thalamus. The defining factors are obtained principally from the work of Head.

DIFFERENTIATION BETWEEN THALAMIC AND SENSORY AREA OF THE CORTEX LESIONS

SYMPTOMS	THALAMIC LESION	CORTICAL LESION
Touch sense.	May be lost on affected half of body. In all cases the objective pain, when present, is definite and the threshold of response is constant.	Sensation present, but the response of the patient to the same stimulus shows a want of uniformity and irregularity of response, so that at one time he may respond to a pressure of 100 gm. and at another 21 gm. may produce on the same spot a response. Tendency to persistence of sensation so that an interrupted stimulus may seem to be continuous. Hallucinations of touch, owing to the persistency of stimulus sensation, may occur. Fatigue quickly results in the part supplied by the affected area. That is, the part may respond to pressure of 30 gm., but will not to 100 gm. Sensibility to touch by cotton wool is never lost over hair-clad parts.
Pain sense.	Objective pain lost in half of body. Subjective pains are present in the same side of the body as the lesion. They are persistent, paroxysmal, often are intolerable and yield to no therapeutic measures. There is a tendency to react excessively to unpleasant stimuli, such as the prick of a pin, painful pressure, excessive heat or cold; on the affected side these produce more pain than on the normal side. Though in some cases the threshold of response may be lowered, it requires a less stimulus pressure on the affected than on the normal side to produce pain. This does not of necessity apply to the stimulus produced by a prick, which may have no reduced threshold.	No change in the threshold to measurable painful or uncomfortable stimuli. No increase or decrease of response to painful stimulus.

Localization.		Power of localization is greatly reduced so that the patient is unable to recognize the part touched. The sensation may be so diffused that a prick on the hand may be felt over the entire arm.	Power of indicating the spot stimulated is very seldom lost in those suffering from a cortical lesion. This power may remain present even though the faculty of recognizing position and posture may be lost.
Temperature sense.	Those sensations are related and any change in one will produce change in the other.	In some cases sensibility to *normal degrees* of heat and cold is lost, though reaction occurs on stimulation with *abnormal degrees* either of heat or of cold, which, when it occurs, is much greater than the sensation produced by the same stimulus on normal halves of the body.	Temperature sensation may not be affected but when it is the neutral zone within which the stimulus was felt to be neither hot nor cold was considerably enlarged in comparison with that observed on similar normal parts of the same patient. The perception of temperature is less plain than over normal parts and the relative difference between two different degrees of temperature is not appreciated, as for instance 40° may seem as warm as 48° or may even be felt as warmer.
Heat and cold.		In some cases the heat and cold sensation may be entirely abolished and may be felt only as a discomfort, and the patient is unable to distinguish whether the object is hot or cold, but in case the sensation is present there is a threshold beyond which point the patient can distinguish between different degrees of heat and cold.	
	Power of appreciating passive position.	Power of appreciating passive position is reduced on the affected side, and in some cases may be lost so that the patient is unable to tell the posture of his limbs.	Power of recognizing posture is reduced. At the same time the power of recognizing *passive motion* is lost. In cortical lesions these two are affected if sensation is at all involved. The disturbance in the faculty of recognizing position or passive motion was greater toward the peripheral parts of the limb.
Compass test.		When tactile sensibility is the same on the two halves of the body the power of distinguishing the two points of the compass is the same on the two sides of the body.	Since the compass test, as it is not dependent on changes in tactile appreciation, can be equally well defined with two painful stimuli, it is, as a rule, not entirely negative.

DIFFERENTIATION BETWEEN THALAMIC AND SENSORY AREA OF THE CORTEX LESIONS—Continued

SYMPTOMS	THALAMIC LESION	CORTICAL LESION
Appreciation of weight.	As a rule is reduced.	Greatly disturbed, patient has lost all power of estimating the relative heaviness of an object placed in the hand, either when the hand is supported or unsupported.
Appreciation of size, shape and form.	May be intact, or may be gravely involved, depending on the state of the tactile sensibility, which if reduced will cause a raising of the threshold of the appreciation as to size, shape and form; by this is meant that a greater difference than normal must be present before the diseased side will perceive it.	Gravely involved, patient being unable to recognize objects placed in the hand.
Vibration (tuning fork).	Resulting sensation present equally on both sides, but lasts a shorter time on the affected than on the sound side, and is not so plain	Generally no appreciable difference felt on the two sides, though on the affected side it may seem to beat slower and is not so plain.
Hemiataxia.	Present, slight.	Present (cerebral).
Astereognosis.	Present.	Present.
Hemiplegia.	Slight, produces no contractions and soon passes away.	Present.
Athetoid, choreic movements.	Present on the affected side.	Never present.

CHAPTER IX

DISEASES OF THE SPINAL CORD

Diseases within and about the spinal cord produce principally two different kinds of pain, namely, back pains and radiating pains. The former are more or less continuous, extending either along the entire vertebra, or occurring in certain regions. The latter occur in the extremities and in the nerve trunk along the peripheral portions of the sensory nerves. It would be of great value in the diagnosis of spinal cord diseases if the pains were at all definitely characteristic. Unfortunately, this is not the case. Moreover, there are a number of diseases of the spinal cord in which pain is usually absent. Here may be mentioned acute poliomyelitis, amyotrophic lateral sclerosis, progressive muscular atrophies of the nuclear type, multiple sclerosis, and various defect anomalies. On the other hand, affections of the cord or of the meninges, especially in the initial stages, are apt to result in pain. Pains localized in the back are also found in diseases of other organs, and there are also in the back radiating pains which are not characteristic of diseases of the cord or its membranes.

It will also be important to consider here those visceral diseases, chiefly of the musculature of the back, whose pains must be differentiated from those originating in the cord or its immediate coverings. Not until disease of other organs, which may give rise to back and radiating pains, is excluded, can the pain be utilized for the diagnosis of disease of the spinal cord. One must, above all, be able to recognize neck, back and pelvic pains, the causes for which are outside of the central nervous system.

There is an entire class of organs, internal and external, which can cause such pains. This class chiefly composes almost all the internal organs of the thorax or of the abdominal cavity. For a consideration of the back pains due to visceral diseases, see page 300.

It will be necessary, in every case of back pain, to exclude the entire class of visceral complaints before one sets to work to indicate the pain as originating from the spinal cord or its meninges. Above all, in doubtful cases a systematic examination of the internal viscera must be undertaken. If these are found unchanged, we must refer the pain to disease of the spinal cord or its membranes. If, however, in connection with back pain one of the internal organs is found to be diseased, the object of the examination will then be to ascertain whether the pains are connected with these organs or with the central nervous system.

CORD CONDITIONS WHICH CAUSE PAIN[1]

In certain cord conditions pain is an important factor. We will discuss some of these seriatim:

Luxation and Fracture of the Vertebra. Luxation and fracture of the vertebra produce severe radiating pains in the arm, trunk or leg, according to the site of the injury. If it lies in the cervical vertebra, it may, through compression of the occipital nerves, cause pain in their area of distribution. If it lies in the thoracic vertebra, it will cause pain by pressure upon the intercostal nerves. The remaining symptoms depend upon the situation and remote effect of the lesion. In addition to the sensory signs there is paralysis below the site of the injury. The loss of sensation begins usually at about the same level, though, as a rule, somewhat lower than the lesion.

No attempt will be made in this chapter to present a complete summary of the clinical pictures of the various forms of spinal luxation or fracture. Such must be sought in special works upon the subject. We can give only a brief summary of the symptoms, laying stress upon the sensory side of the picture:

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[1] Written by Dr. Alfred Neuman, Vienna.

The most classical pictures are produced by cervical, dorsal, lumbosacral and cauda equina lesions.

The most frequent cause for the first type is direct injury, diving, falls, falling of heavy weights. Either dislocation or fracture may occur. One finds forward displacement of the head, there are usually myosis of the pupils, greatest on the side most injured, narrowing of the palpebral fissure, retraction of the eyeballs—which eye signs are due to involvement of sympathetic centers in the first dorsal region of the cord (Dejerine, Klumpke). There may be no pain, but there are usually anesthesia and analgesia below the level of the lesion. The muscles affected indicate the level of the lesion in the cord.

Movement of the head or neck, however, is apt to create sharp radiating pains at about the level of the injury. Local pain on pressure is present.

Dorsal injuries cause similar pictures lower down. They are usually very severe.

Lumbosacral and caudal lesions affect the movements of the legs and the functions of the bladder, rectum and sexual organs. Lesions here are apt to result in much pain, especially in injury to the cauda equina. In isolated cord lesions, pain is apt to be missing, but in caudal involvement, especially later in the disease, pain is frequent and very often severe.

A study of the anesthesia and the muscles involved is necessary to locate the precise site of the injury.

Meningeal Apoplexy. Likewise in spinal cord hemorrhage, as the result of a trauma, pains occur. They may be very severe, are localized in the back and are limited either to a part of the same (pelvis, interscapular region, or the neck), or spread over the entire vertebral column. Pressure on the vertebrae causes a slighter increase of pain than does motion; consequently, the vertebral column is held in a stiff position. In like manner radiating pains occur in the upper or lower extremities, according to the location of the lesion. The remaining symptoms of the disease present themselves in cramps, tremors, and contractures in the arms and legs.

Hematomyelia.— Sudden hemorrhage, occurring within the spinal cord, in the majority of cases causes pain. Some hematomyelias run a painless course. The location of the pain corresponds to the level of the affected area, and appears either as back, shoulder, pelvic or leg pain. Stiffness of the vertebra and pressure sensibility of the same are present in involvement of the meninges. The patient presents a sudden interruption in the conduction paths. The remaining symptoms, produced through the position and the spreading out of the area, are disturbances of sensibility, bladder and rectal paralysis, atrophies, participation of the arm, or half-sided paralyses, etc.

Caries of the Vertebral Canal.—In this disease pain plays an important part. It appears very often as local pain, increased on motion, and limited to the diseased vertebra. The result is that the patient guards against exercise involving the diseased part, and holds it in a stiff position. He also avoids displacement of the diseased vertebra. With the local pain, radiating pain appears, earlier or later, and has different localizations, according to the vertebræ involved. In disease of the highest cervical vertebra the pain radiates, through the occipital nerves, to the head (neuralgia) If the cervical cord enlargement is damaged by bone disease, the pain radiates into the arms. In compression of the dorsal cord girdle or intercostal pain occurs; and, finally, there is lancinating pain in the limbs in affections of the lower enlargement of the cord. The pressure sensibility of the spinous processes of the diseased vertebræ is especially characteristic. It is very pronounced, and is proportional to the amount of pressure used. On the contrary, in neurasthenia and in hysteria (diseases in which pressure sensibility of the vertebral column is observed), there is greater sensitiveness to a light touch of the skin, on the elevation of a fold, than to a strong pressure. In hysteria, pressure pain is often greater lateral to the spinal process than it is over it, and is influenced by suggestion. As characteristic of caries, the readiness with which the skin lying over the diseased vertebræ responds to pain, to electrical and thermal irritation is especially pronounced. The other most important symptoms are the acute kyphosis, through collapse of the diseased vertebræ, the descending abscess (on the posterior pharyngeal wall, along the psoas muscle, or into the inguinal fossa or on the back), and the symptoms referred to the spinal cord or the spinal roots.

Tumors of the Spinal Cord and Vertebræ.— For the diagnosis of these conditions, local painfulness of the vertebral column and radiating pain must be differentiated. The former corresponds to the location of the tumor, and is increased, especially upon bending forward and on shaking the head. This symptom, however, is not always present It is possible that an inequality exists between the strong, spontaneous pain and the lighter pressure sensibility According to Petren, only a diffuse painfulness of the vertebral column can be a symptom of cord tumor.

More frequent and more clearly pronounced are the neuralgic pains which arise from pressure on the posterior roots. As a rule, they are described as intermittent or remittent, and may be present, according to the location of the tumor, in different parts of the body. If the tumor is present at the cervical enlargement, it causes radiating pains in the areas corresponding to the thoracic vertebral column, girdle pains around the thorax, and shooting pains in the region of the stomach or bladder. When the tumor is located still lower, sciatic pains, on one or both sides, are often the first symptoms of the not yet apparent disease

In addition to tumors involving the cord itself, as causes of pain, one should also bear in mind those affections of the vertebræ which either themselves encroach upon the cord, or which produce such changes in the bones that they make pressure upon, or cause involvement of the cord. The most important of the bony disorders of the vertebræ is tuberculosis. Here there is found localized tenderness over the spinal vertebræ, usually sharply limited to one or two segments. The general meningeal pain develops later, whereas the more severe pressure pain originating from the pressure on the roots accompanies the settling of the vertebræ, i. e., more or less synchronous with the kyphosis. In caries, also there is no Wassermann, in the fluid the number of cells is rarely high, the globulin content nil. (See Caries of the Vertebral Column above.)

Gummatous masses act like tumors at times, and cannot be differentiated clinically.

Acute Spinal Meningitis.—If a spinal meningitis is added to a cerebral meningitis the symptoms of the spinal trouble are the more prominent. Intense pain is frequently observed. There is also a local painfulness of the spinal column, especially pronounced in the lumbar region. The pains are increased by pressure and shaking (coughing, sneezing), but especially by active and passive motion. In the same manner the simultaneously occurring pains radiating into the arms and legs are increased. For this reason the patient holds the vertebral column in a rigid position.

Pachymeningitis Spinalis Hypertrophica.—In this disease we find pains in the neck, in the occipital region between the shoulders, and along the spinal column; the point of localization depending upon the location of the diseased areas. In addition to the local symptoms radiating pains in the extremities and in the trunk occur. In the cervical variety the neuralgic pains correspond to the course of the ulnar and median nerves.

Myelitis.— Pain, which is not the most important symptom in this disease, is found especially in the beginning stage, or as a prodrome. In the chronic stages pain is not a constant sign. Back pains, varying according to the location of the diseased areas, girdle pains, corresponding to the upper boundary of the disturbances of sensibility, or lancinating pains in the extremity, generally not of great intensity, are present. Pressure sensibility, as well as percussion sensibility, is almost never found.

Poliomyelitis of Children.—In the prodromal stages of the disease pains are present in addition to fever, convulsions and vomiting. These pains are apt to be very diffuse, but are especially severe about the neck and occiput, often being more suggestive of a cerebrospinal meningitis than a poliomyelitis. Diffuse pains of the extremities and marked hyperesthesia, resembling these signs in influenza, are extremely frequent, especially in some epidemics. A poliomyelitis may run a course indistinguishable from a polyneuritis, save that in the latter bony sensibility is apt to be involved. It is rarely implicated in poliomyelitis. Associated with poliomyelitis is paralysis, which generally occurs suddenly in the course of the night, in from two to seven days, and affects either one or more extremities, generally one or both limbs. The paralysis is flaccid, and the skin and tendon reflexes are absent. After a short time atrophy of the muscle and reaction of degeneration are demonstrable. Then the affected limbs feel cold and are livid in color. Atrophy and secondary contractures ensue in many cases.

Syphilis of the meninges and of the cord causes pains in different parts of the vertebral column, which are increased through movement and pressure, are of great severity, with nightly exacerbations, and are combined with radiating pains in the extremities and the trunk (girdle pain). Through compression of the anterior roots there also occur atrophic paralyses of the extremities and of the abdominal muscles. The participation of the spinal cord can be seen through an interruption (very incomplete) of the conduction. Spastic paralysis of one or both extremities is also of frequent occurrence. Babinski's and Oppenheim's signs are then present, as well as disturbances of sensibility in the rectum and bladder. The frequent change of the disease picture is characteristic. Paralysis may be present one day and then disappear, and it may frequently be observed that paralysis and perfect motion follow one another in the same region.

Multiple Sclerosis. –The pains are similar to those found in tabes, but are much less frequent. Some pain is observed along the spinal column. The remaining symptoms are familiar, namely, spastic paretic symptoms in the extremities, intention tremor, scanning speech, nystagmus, passing disturbances of sight, with paleness of the papilla, headache, dizziness, and mental signs. In the later stages, marked by intense contractures, pain is often very intense. It is due to the contractures and may also appear early in the disease as short stabs, occurring at the time of a contracture cramp of the extremities, principally the lower.

Syringomyelia.—The pains which are most often observed in this disease are similar in character to the lancinating pains of tabes dorsalis. They are often very severe, and radiate into the limbs (sometimes into all four) and around the trunk. The other symptoms concern the development of atrophic paralysis, principally, at first, in the upper extremities, beginning in the small muscles of the hand. The sensory syndrome consists in a retention of epicritic touch sensibility, but a loss of pain and temperature sensibility. Vasomotor and trophic disturbances are frequent from involvement of protopathic conduction fibers.

Tabes Dorsalis. The pains in tabes dorsalis are localized sometimes on the surface of the body, sometimes in the hollow visceral organs. The former appear as lancinating pains in the extremities, or as girdle pains around the trunk. These pains form one of the first symptoms, and often appear many years previous to other symptoms of the disease. They come on abruptly, while the patient is in the best of health, and soon reach a great intensity. They are situated, as a rule, less frequently in the upper than in the lower extremities. In the former case, they are usually not so severe In the legs they may reach their greatest intensity. The pain suffered by different patients, however, varies in intensity. It is seldom felt in the skin, but, instead, usually deep in the muscles or in the bones. The attack itself may last for a few seconds at first, then, later in the disease, a few minutes, then, in the final stages, may persist for hours. The incidence of the attacks seems to at least partly depend upon outside factors, as weather, worry, wine, and women. The girdle sensations indicate only different localizations of the lesion. They appear as pressure, tightness on the breast, as though the patient were bound by an iron band, or as pressure sensation of the stomach or bladder. Pains in the maxilla, teeth, or ear may occur in tabes, in fact, in the distribution area of any sensory nerve. The pains which arise in tabes in the internal organs (stomach, bladder, intestines) occur paroxysmally, and are often of extreme severity, when they are termed tabetic crises. Such crises are not infrequently very early. The best known are the stomach crises.

A patient in perfect health suddenly has excruciating pains in the stomach, usually accompanied by uncontrollable vomiting. Radiations into the shoulders occur. Some patients scream, sigh, and toss in bed, while others remain perfectly quiet. This condition lasts a few hours, or days, rarely longer. Then the picture changes. The pains and vomiting disappear, and the patient is able to eat everything without distress, the same as though he were in perfect health. These intervals of freedom last for different periods, sometimes months or years Then other crises occur. In the intestines the crises arise as colicky pains associated with diarrhea; kidney crises, with pains similar to those of renal colic, also occur; bladder crises, ureter crises, and clitoris crises, corresponding to pains in these organs, eye crises, sudden pains arising in the eyes, joined with redness, lacrimation and contraction of the lids; laryngeal crises, sneezing crises, etc., also occur.

The associated symptoms are so numerous that only the most important can be mentioned, namely:

(1) Disturbances of sensibility, and, in addition to the pain, paresthesias, especially in the extremities, paralysis of sensibility of the skin, of the muscles, and of the joints.

(2) Disturbances of the reflexes with absence of the patellar reflex or of the tendon achilles reflex, the tendon reflexes of the upper extremities, and of the pupil reflexes (Argyll Robertson).

(3) Ataxia of the extremities, shown by the finger-nose test, finger-finger test, knee heel test and by Romberg's test.

(4) Bladder and rectum disturbances, especially incontinence.

(5) Trophic disturbances leading to spontaneous fracture, atrophies of the joints, arthropathies, falling out of the teeth, and perforating ulcer.

(6) Eye symptoms, which are often temporary, ptosis, ophthalmoplegies, optic nerve atrophy.

Neurasthenia. Pain in the back of the head is a frequent complaint of many neurasthenics. It is localized to a circumscribed part of the vertebral column, or spreads out over the entire circumference. One finds pressure sensibility in a lesser or greater part of the spinal column corresponding to the location of these pains. *It is characteristic that strong pressure is often felt to be less painful than light pressure.* The pains are not as severe as they are described, as may be seen by the ease with which the patient's attention is distracted from the pain. Radiating pains in the trunk and in the extremities are also frequently described. In regard to the other symptoms of neurasthenia, they are so numerous that the mere enumeration would be too extensive. They may be found in text-books of neurology.

Hysteria. The pains of hysteria are similar to those of neurasthenia. Pressure sensibility in the back, over one or more spinous processes, as well as the other peculiarities of neurasthenia, are present in hysterical back pain.

Traumatic Neuroses. If the trauma strikes the spinal column directly or indirectly, pain which hinders the patient from making active movements may occur in the involved area.

General Summary. It is even far more difficult to draw diagnostic conclusions from the character of spinal pains than it was from headache pains. They have little of characteristic peculiarities. The nightly exacerbation of luetic pains, as a single exception, is almost the only one pointing directly to an etiological factor. In spinal cord affections, local pain, local pressure sensibility, and radiating pains are singly or in combination diagnostic criteria of value. They may occur separately, but are usually found together. Diagnostic conclusions can rarely be drawn from the severity of the pains alone. The highest degree of radiating pain is found in caries and tumors pressing upon the spinal cord, as well as in meningeal apoplexy, meningitis, and meningomyelitis. The severity of the pain depends more upon the extent and the degree of the process than on its nature, so that the intensity of the pain, in the diseases described, may be greater or less, according to the stage of the disease. It should be observed that pains in the back, along the entire spinal cord or a greater part of it, in neurasthenia are almost always of a minimum intensity, though they are described by the patient as being very severe. Observation of the patients, however, shows that they are bearable pains.

In most cases of localized spinal affections the pains are not spread out over the entire vertebral column, but affect only circumscribed parts of one or a few vertebræ. A pain limited to a circumscribed area frequently is valuable for a diagnosis; not so much for the recognition of the trouble itself, as for the determination of its location. The sudden darting pains of tabes are almost pathognomonic, as are also the crises pains.

CHAPTER X

PAIN IN THE TISSUES

MUSCULAR TISSUES

Muscles are subject to pain and seem especially to be affected in the acute infectious diseases, or in those conditions which go by the rather loose term "colds." The majority of these diseases are due to bacterial invasion, with the production of toxins, and it is these toxins which seem to have a selective action on the sensory nerve receptors distributed in the muscles.

For a long time it was not definitely known that sensory nerve receptors existed in muscular tissue. Sherrington, however, demonstrated the existence of such organs, and Head, by his thorough technique, showed that the origin of deep sensibility was undoubtedly muscular and tendinous. As yet, though we know that they exist, the sensory end organs in the muscle tissue have not been definitely isolated. In some cases these end organs, or sensory nerve filaments, become hypersensitive. The hypersensitiveness may be confined to the muscles alone, the overlying skin being uninvolved or both the skin and muscle may be involved. Tenderness of the muscles may be elicited by grasping them between the fingers, or by making pressure on them. At the same time pinching the skin may give no reaction, for the reason that the deep sensory system may alone be affected, the skin systems not being implicated.

In a consideration of the pain-producing diseases of the muscles it is better to divide them into the voluntary and involuntary, for what would produce a painful reaction in the voluntary often has absolutely no effect in involuntary muscle; for instance, inflammation in voluntary muscle gives rise to very severe pain, while in involuntary muscle it may not produce the least sign of its presence. In either case the stimuli which react to cause pain are the same, but those in the voluntary muscles act upon sensory termini which are accustomed to respond to inflammatory irritative stimuli by pain, while in the involuntary muscle the sensory termini have had no such training, and react only in response to an entirely different set of stimuli. In the voluntary muscles the pain syndrome may be produced in a flaccid muscle by the action of bacterial toxins on a sensory nerve terminal, while in the intestine it is necessary that to the bacterial invasion a contraction of the muscle fibers also be added before pain is produced.

A condition in which all voluntary movements have been associated with great pain has been described by McCarthy (Osler's System, VI, 569). He terms it Akinesia Algera.

VOLUNTARY MUSCLES

The diseases of voluntary muscle causing pain are myositis, acute polymyositis, myositis fibrosa, myositis ossificans and myalgia.

Myositis.—When inflammation of a muscle (myositis) occurs, the pain is found in definite areas corresponding to the muscular distribution. The pain may be so severe, and every movement so provocative of pain, that the patient is unable to move, and lies in bed like one paralyzed. Different groups of muscles may become involved successively. The involved muscles, as a rule, are greatly swollen. The pains are described as drawing, tearing, or boring (Steiner). In other cases, no definite inflammatory state can be defined, but severe pain is produced on movement of a certain group of muscles. This is very common in women of feeble muscular development, and is "felt at the attachments of the abdominal muscles to the ribs, or along the attachments of the erectors of the spine. These, in reality, are stretching pains, and are due to an abnormal pull upon the tendinous structures from deficient muscular support" (Thompson, 36). In these cases the skin may be very hypersensitive over the insertion of the involved muscles (Moullin, 226). In other cases pain is present in the skin over the entire extent of the involved muscle. This would seem to lend credence to that part of Hilton's law which states that skin over involved muscles is tender in disorders of these muscles, because both have the same nerve supply. This cannot always be true, however, because, as already explained, while the muscle and overlying skin might originally have been supplied by the same nerve or nerves, yet, owing to development and consequent change in the relative position of both the skin and its underlying muscle, it frequently happens that the skin is displaced to a considerable distance away from its original position over its nerve related muscle.

Of the acute forms of myositis the suppurative variety soon lends itself to ready diagnosis, not from the pain, which at first resembles that of a generalized neuralgia, or is of a rheumatic type, but from the rapid localization in the involved muscle of the characteristic tender indurative swellings, hard and board-like in character. Muscular contractures are the rule. Softening and fluctuation soon determine the true nature of the pain. Suppurative myositis may be multiple or isolated.

Acute Polymyositis. The form of myositis which has just been discussed is largely a local affair affecting one muscle or a small group of closely related muscles. In persons of early or middle life there exists, however, a form of acute generalized inflammation of the muscles—a polymyositis—in which pain is a prominent symptom.

This disorder, frequently a complication of other infectious disease, also of generalized toxemic states, usually begins with acute constitutional symptoms, malaise, headache, nausea, vomiting. Dragging pains then occur, with frequent cramps in the entire musculature. At first the sore spots are fairly well localized, tender to pressure and to passive motion. Then a period of inflammatory edema makes its presence manifest by swelling and hardness of the parts. These swellings may at times give the muscles a somewhat grotesque appearance. The skin is tense, often reddened, and may show exanthemata, erythema, urticaria, or vesicles. The electrical excitability diminishes, and atrophy takes place after the hypertrophy has disappeared. The epicritic sensibility is unimpaired. Careful search should always be made of the blood picture, as certain forms of polymyositis are associated with eosinophilia, which not infrequently has as its underlying cause a localized or generalized trichinosis. Other parasites are described.

Myositis Hæmorrhagica.—In myositis hæmorrhagica pain is the first symptom. It is usually sharply circumscribed to a spot in the muscle where a small nodular, palpable tumor usually develops. Edema soon sets in and hemorrhagic areas are observed, which soon show the familiar yellow-green discoloration.

Myositis Fibrosa.—Myositis fibrosa often shows itself in sharp pains in the muscles, the lower extremities usually being first implicated. The disorder advances slowly, going from one muscle to another, and the patient, after several months or years, is unable to move about because of the pain and rigidity. Contractures occur, but sensory disturbances are rare. Palpation is usually painless in this particular variety, and much weight is laid by Lorenz upon this feature in diagnosis. The muscles get harder, but the spontaneous pains become less pronounced.

Myositis Ossificans.—In myositis ossificans the pain often masks the case as one of "rheumatism." In some pain is lacking in the early stages. The usual signs of myositis are present in most cases, with radiating pains. Following an attack, the pain subsides, but the muscles remain hard and indurated. Other attacks come and go, the indurations becoming harder and harder, until bony masses are evident. The disorder is found most frequently in the muscles of the back and neck, the face and upper extremities less frequently, while the muscles of the lower extremities are rarely involved. The gradual rigidities that develop with the deformities are very striking.

Myalgia.—Torticollis and lumbago are the most classical of the myalgias, although any muscle of the body may show this peculiar disturbance. Myalgias are very frequent, yet, notwithstanding, the cause is very obscure. Exposure to cold and traumatism are among the most frequent etiological factors.

The pain is usually sharp, especially when the parts are moved and the muscles forced to functionate, actively or passively. In torticollis, in which the sternocleidomastoid is affected, the patient holds the head to one side, and the pain is very severe and is usually unilateral. In lumbago the pain is in the back. The onset is usually sudden, often following a muscular strain; every movement becomes extremely painful, and the position adopted by the patient is very characteristic. He walks with a stiff, short tread. Lumbago may be confused with spinal arthritis, with sacroiliac disease, with malignant spinal growths, or even tuberculosis of the spine. Other muscles (pleurodynia, scapulodynia, dorsodynia) afford other special pains and special postures.

The muscles are often somewhat painful to pressure, and occasionally they are indurated; at times the induration is soft, again it is hard. Counterirritation and massage often relieve the condition very rapidly.

INVOLUNTARY MUSCLES

Colics. —Thus far only voluntary muscles have been considered. Involuntary muscles, also, are the site of pain sensation, especially those which are present in the hollow viscera. Here the pain is associated with contractures or spasms. These contractions or spasms, when they occur in the intestinal, genitourinary, or biliary tracts, are called colic. The pain in colic is constant, as a rule, but may have periods of greater or less intensity. Of all colics, perhaps, that of the common gall-duct is the most severe.

Colicky pains show variations. In some cases there is a sudden increase of pain, which persists for a longer or shorter period and suddenly disappears. In another type the colicky pain comes on suddenly, then remits, and in a few hours returns and becomes very severe. This may be repeated many times. In a third variety the pains at first are light, but become of gradually increasing intensity, with an incomplete remission between the paroxysms until a paroxysm of maximum intensity occurs, when there is a gradual remission and return to the normal.

Several factors enter into the causation of colicky pain. (1) The pains may be due to the overdistention of a portion of the canal lying between a distal, non-moving, contracted part of the canal, and a movable, contracting part, the movable part gradually approaching the stationary part until the contents in the intervening canal are put under great pressure and consequent dilatation and overdistention of the canal take place. This overdistention causes a stretching and pressure on the nerve terminal filaments in the wall, and pain results. Normally this overdistention does not occur, for it is a rule, in all hollow muscular viscera, that contraction of one portion is followed by relaxation of the next adjacent portion. It is only when this law, called by Meltzer (105b) the "law of contrary innervation," is at fault that colic occurs.

(2) Pressure may be made upon the terminal nerve filaments by the contracting muscles.

(3) Traction and pull is made on the mesentery by the inequality in position of the contracted and noncontracted segment.

(4) During contraction of the bowel it tends to straighten out and this causes a pulling and stretching of the mesentery. In fact, it seems that this is the most reasonable hypothesis. This is contrary to the idea of Hertz that tension is the only true cause of hollow visceral pain. In intestinal colic, relief almost at once follows the onward passage of the feces. The pain of intestinal colic is not felt so much in the viscera, but is referred to the anterior abdominal body wall, and follows the law of segmental distribution (Head). Hertz, on the contrary, claims that the referred pain is rarely present alone to the exclusion of a *true visceral pain,* but that the visceral pain is often present to the exclusion of the referred pain.

FATTY TISSUES

Adiposis Dolorosa. — In this condition, first described by Dercum in 1888, pain is a prominent feature. It is a pain, however, that is more the result of pressure than spontaneous, although there usually are burning, lancinating sensations present in the fatty masses, which form the characteristic features of the disease.

Diffuse collections of fat, scattered over the body, are found in several conditions. Adiposity shows itself under several forms; chief of these are the adiposis tuberosa of Anders, adiposis cerebralis of Frohlich, formerly prophyseal or epiphyseal disease (Marburg, Jelliffe), symmetrical adenolipomatosis, multiple lipomatosis and adiposis dolorosa. These are probably closely related conditions, and pathologically some relationship to the ductless glands, particularly the hypophysis, is probable.

Adiposis dolorosa varies from the others by reason of the pain and tenderness of the fatty masses. This pain is probably the result of an associated neuritis, since neuritic lesions have been found in a number of cases. Furthermore, tender nerve trunks, trophic changes, and sensory symptoms go to round out the picture of a neuritic involvement.

The fatty areas, as they develop on a basis of a general adiposity, are usually edematous and tender Pressure induces an exquisite painfulness, and leaves behind it burning, lancinating sensations. The areas have a tendency to disappear, leaving indurated spots, then recurrences take place, and nodular tumors develop These nodules, which are very sensitive —even to the slightest touch often giving rise to exquisite pain, are found principally over the trunk and extremities. The face, hands and feet are free. Cases are also met with, with no nodules. Here there are large indurative areas, sensitive to touch and palpation. There is a tendency for these areas to become less sensitive, but nodules which remain in the fat retain an exquisite tenderness, and are the centers for neuralgic like radiating pains.

Pain is present usually at all times. It may be an initial symptom, coming on before there are any fatty nodules. It may be dull, lancinating, or burning, rarely is sharply localized to any nerves, but is usually associated with tender nerve trunks.

Asthenia, querulous irritability, mental apathy, and depression are frequent associated conditions, while general neuritic signs, such as anesthesia, hyperesthesiae, vasomotor disturbances, hypersecretion, cyanosis, dermographia, ulcers, ecchymoses, all contribute to the general evidence to show some implication of the protopathic system

In all cases of adiposis dolorosa examination should be made for hypophyseal symptoms In many cases of this disease an adenoma of the posterior lobe of the hypophysis has been found (Pick).

CHAPTER XI

BONE PAINS—THE OSTALGIAS

GENERAL CONSIDERATIONS

When pain occurs in a limb over a region where bone involvement is a possibility, it is necessary to consider lesions of structures overlying the bone, as well as those of the bone itself. It is only when pathological lesions in the overlying structures have been eliminated that the bone should be considered as at fault. When a patient complains of pain in bony structures it is necessary first to obtain a history of the pain, its type, manner of onset and character, and then to proceed to a physical examination of the affected region. Of the physical methods of examination made use of in the elucidation of bone symptoms, palpation is productive of the best results. If palpation over a limb or a part where bone is a prominent structural component discloses only superficial pain, the bone can be disregarded as the chief cause of the pain; yet it should always be borne in mind that a lesion, which at first may have commenced in the bone, may progress so that adjacent tissues are involved and secondary lesions ensue. These may be far worse, and produce symptoms of much greater severity than the original disorder, so that often in the medical survey the secondary lesion intrudes itself to such a degree that the original primary condition is overlooked. As a rule, however, if tenderness and pain are both superficial, and there is no history of a previous deeper pain, the bone may be disregarded and the superficial tissues considered as being at fault (bone lesions are tender and painful on deep pressure).

TYPES OF PAIN

In our examination as to the cause of the bone pain, inquiry must be made as to its type, i.e., whether it is continuous or intermittent.

Continuous pains are due to persistent acting causes, such as new growths, inflammation or aneurysm. New bony growth generally produces a dull, aching pain, which, as a rule, is fairly well localized to the area affected. Inflammation of bone produces a continuous pain, which is interrupted at times by paroxysms of greater intensity. Pressure on a bone by a growing tumor or an aneurysm (with gradual erosion of the bone) causes a dull, aching pain of great severity. In this condition there is a sharply defined area, exquisitely tender to the touch, corresponding to the site of the bone involvement. Other signs of tumor or aneurysm are also present.

Intermittent pain in bony lesions is divided into two classes; in the first, the pain occurs spontaneously, without any excess of local irritation, and generally indicates a more severe process than in the cases where pain is felt only on pressure. When pain is only felt on pressure (if the bone is only slightly involved) it disappears from the part as soon as the pressure is removed; but in more severe cases it may persist for some time after the removal of the pressure.

In some cases there are recurring attacks of very violent pain, with great tenderness at the point where the pain is felt. When this pain and tenderness are accompanied by local swelling, fever, and a rapid pulse, osteomyelitis should be considered. Pains of this type, spontaneously occurring at intervals without any apparent existing causes, are called spontaneous intermittent pains. The other forms which can be produced by pressure are called pressure intermittent pains. These occur generally in association with an inflammation and are either mild or severe, depending upon the amount of pressure which is necessary to be exerted on the part to produce pain. Among the pressure intermittent pains are those due to osteomalacia and osteomyelitis.

Diurnal variation of the pains is of great value in the diagnosis of bone lesions. Pains due to certain diseases seem to appear at regular and definite periods of the day. Syphilitic and tuberculous bone pains are generally worse at night. A point of importance is that luetic pains are always relieved by mercury and the iodides, and tuberculous lesions give tuberculin reactions and the serological test (Wassermann's) is present in lues. Nocturnal ostalgia is very common in typhoid fever, especially in patients in whom the bone marrow is involved, so that when a limb pain is present in those convalescing from typhoid fever the bone should always be examined.[1]

CHARACTER OF BONE PAIN

According to its severity bone pain may be classified as sharp, piercing, dull, or aching. When the pain is *sharp*, it is generally of sudden onset, and comes without warning. If it is very severe, and is sharply localized, osteomyelitis is most likely to be present. Piercing pain is not common in bone disease, and, when present, neuralgia should be sought.

Dull and aching pain is characteristic of syphilitic lesions. When present an examination for past or present syphilis should be made. It is also present in periostitis, in which at the point of periosteal thickening a dull pain, with at times more or less acute exacerbation, is felt. When the periosteum is diseased, a well-marked, localized thickening will be found on X-ray examination.

LOCALIZED BONE PAIN

With reference to extent, bone pains may be classified either as localized or diffuse. Localized bone pains are due to periosteal lesions, traumatism, new growths, and inflammation.

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[1] It seems that the medulla of bone, perhaps the endosteum, is much more sensitive than the periosteum, for recently in our (Dr. Schultze and myself) work on bones we have found that the cutting of the periosteum or the trephining of the cortex was not especially noticed by the morphinized dog, but as soon as the drill penetrated the medullary cavity he became restless and whined very much. Later in the experiment, when it became necessary to introduce a sound or curette into the narrow cavity, he again showed signs of apparent pain.

Periosteal Lesions.—The periosteal lesions causing pain are, as a rule, inflammatory. If the inflammatory changes occur at the point of the insertions of muscles or tendons, any activity of the muscles or movement of the tendons will cause pain, and in some cases this may be confused with pain produced in the bone itself. In periosteal inflammation tenderness is sharply limited, which, as a rule, is not the case in lesions of the bone itself. The tenderness is nicely defined by running the finger down to and over the inflamed area. In lesions of superficial bones like the tibia marked pain is evinced as soon as the finger crosses the border of the inflamed area.

Should swelling of the periosteum occur without pain, it may be due to a new growth which causes pain only when the subperiosteal distention becomes so great that pressure is made upon the sensory nerve filaments terminating in the periosteum.

In children the so-called growing-out pains are often the result of slight septic processes in the periosteum. They often appear after acute infection, tonsillitis, etc.

Traumatism.- Here the pain is of sudden onset and immediately follows the injury. If the part is too tender to palpate, an anesthetic may be used, so that a proper diagnosis of the condition can be made. If possible a skiagraph of the part should be taken. This will save considerable manipulation of the injured region, and will lessen the necessary pain to the patient. If the X-ray is not available the presence or absence of fracture should be determined from crepitus and false motion. If a fracture is found its probable direction and extent should also be determined. Following an injury, if localized tenderness is present and the bone has not been broken, bruises and contusions must be considered. These may also occur in the periosteum, in which case the tenderness is present as a rule only on deep pressure. It is necessary to consider fractures, bruises and contusions separately. In some severe injuries all these may be included in one lesion, which is called a crush.

Fracture.—In fractures pain may be entirely or almost entirely absent, particularly when the fracture is an impacted one.

This occurs only in the absence of laceration of the adjacent parts. Pain may also be absent when the fractured ends of the bone are separated by a considerable interval. In fractures pain is elicited by two methods: First, by passive motions, to produce which the limb is grasped so that one hand is above the line of fracture and the other below it, and to and fro movement is made so that there is motion between the fragments; when a fracture is present, pain is felt, sharply localized at the point of fracture. Second, if pressure be now made over the point of greatest pain, a well-marked area of tenderness, corresponding rather closely to the line of fracture, is found. In some fractures the line of the fracture may be outlined by the sharply defined area of tenderness immediately above it. This line of tenderness is very useful in diagnosing a greenstick fracture in which crepitation and false movement are absent. In certain cases of impacted fractures, for instance, those of the femur, great care should be exercised in the manipulations, so as not to break up the impaction; otherwise, especially in old people, a condition in which union does not occur will result. A point of considerable importance to remember in the diagnosis of fracture is that tenderness persists for a considerably longer period in a fracture than in a simple contusion. If the pelvis should be injured and a fracture suspected the crests of the ilium should be forcibly pressed toward the middle line. When a fracture is present there is a well-marked and sharply defined pain at the point of fracture.

Contusions.—Bruises and contusions generally are the result of direct violence, and are localized in extent. The periosteum is markedly elevated and under it a blood clot, felt as a soft, fluctuating mass, may be present. If in a lesion of this kind in which the swelling is beneath the periosteum the pain increases, instead of decreases, it is likely that infection has occurred, particularly if the swelling continues to increase in size and becomes softer.

New Growths.—As a rule, new growths of bone are not painful (?) until the periosteum is involved, or until pressure is made upon adjacent tissues, when they give rise both to local and referred pain. Resembling new growths, tuberculous disease of the bone may be present for some time without producing pain, but, as a rule, it soon gives rise to a dull aching, which, if the adjacent joint is involved, is interrupted by sharp paroxysms.

Septic Involvement. Septic involvement of the osseous system is frequently encountered during pneumonia and malaria. It also is common during the course and convalescence of typhoid fever, the bones most frequently affected being the ribs, tibia, femur and clavicle. This septic involvement, and, in fact, all inflammatory changes, can occur only in the bone marrow and the cancellous tissue because the hardness and density of the cortex inhibit inflammatory reactions. To these inflammatory processes the name osteomyelitis has been given. The pain of acute osteomyelitis is of the greatest intensity. According to Nichols, it is the most intense of any pain with which we are familiar. Osteomyelitis of the long bones often commences with a sharp, sudden pain in the vicinity of the epiphyseal line. A sign of great significance in the diagnosis of osteomyelitis is that continued, gentle pressure on the shaft of the bone, at a distance from the area of greatest pain, will at first produce no pain, and then, very suddenly, there will occur a sudden short exacerbation of great severity. Acute osteomyelitis generally gives acute symptoms, but it must not be forgotten that, either following such an acute attack or arising *de novo* a chronic osteomyelitis may be present and give rise only to a dull aching, in some cases, gnawing pain in the affected area.

Changes in the structure of a bone not only may be the result of germ infection, but may also be produced by diseases of the hemopoitic system such as leukemia and pseudoleukemia. In such conditions pain is frequently present in the lower part of the sternum. It is produced by pressure against the bone. Such pressure may occur while leaning against the edge of a table, in writing, on resting on the window sill, or on bending over the washtub. Pain of this type is often the first manifestation of leukemia or of a pseudoleukemia.

Schmidt has made the interesting observation that in leukemia and pseudoleukemia the sternal pains are controlled by arsenic, and that during the period of greatest activity of arsenic the pains are less troublesome. He has also found that the bone pains increase and decrease with the increase and decrease in the number of the leukocytes.

GENERALIZED BONE PAIN

The diseases causing generalized bone involvement and giving rise to pain are: Osteomalacia, diseases of the hemopoitic system, and new or abnormal growths.

Osteomalacia occurs most frequently in association with pregnancy. The pain is usually found in the lumbar region and in the lower extremities. It is produced by any action which causes motion in the affected bones. Such actions as walking, stooping, rising from a sitting to a standing posture, laughing, sneezing and coughing produce great distress. Schmidt well describes it thus: "On getting out of bed, the patient subject to osteomalacia carefully lifts out each leg in turn, holding it by the thigh." Deep respiration often gives rise to pain in the ribs. Descent of the stairs is sometimes more uncomfortable than the ascent, because of the jarring of the body that it occasions. While moving about is exceedingly arduous, remaining in the same position for any length of time, either sitting or lying, results in an increase of the pain. The patients are thus obliged to change their positions constantly, and their sleep is very broken. Abduction as well as rapid dorsal flexion of the hip causes paroxysms of pain located at the ankle joint. In the latter case the pain often runs the entire length of the lower extremity, radiates to the pelvis, and is sometimes accompanied by dorsal clonus. Lateral compression of the thorax, or of the pelvis at the level of the trochanters or iliac crest, promptly causes pain. The wearing of a corset and tight lacing sometimes appear to relieve the subjective symptoms, evidently through the support given to the spinal column. Osteomalacia should be carefully diagnosed from spondylitis of the dorso-lumbar region, in which, during the early stages, the character of the pain may be somewhat similar.

Diseases of the hemopoitic system, as leukemia and pseudoleukemia, also cause aching pains in the long bones. (See above.)

New growths of bone are sarcoma, carcinoma, myeloma, lymphadenoma ossium, and chloroma.

Sarcoma and Carcinoma. Should pains be associated with a tumor mass and at the same time with cachexia, search should be made for malignant bone disease, and one of the best methods of diagnosis is the X-ray. In suspected cases the adjacent lymph glands should also be examined for swelling and the skin should be inspected for the red lines caused by affected lymph radicles (running from the site of the disease to the nearest lymph gland).

Myeloma, lymphadenoma ossium, and chloroma cause diffuse pain and are associated with the symptoms of internal lesions. Malignant metastatic growths also are frequently found in bone, and cause pain which at first may be delimited and localized, but finally, with the involvement of the entire bone, the pain also becomes diffuse.

Abnormal growths of bone causing pain are osteitis deformans, and leontiasis ossea.

Osteitis Deformans. In case of long-continued pain in the legs with occasionally tender points over the bone, osteitis deformans, or Paget's disease, may be found. Its presence is further indicated by the constantly increasing size of the head.

Leontiasis ossea is also a rather frequent cause of bone pain.

Spurs growing out from bone are also a source of pain. When they grow out of the os calcis, they are often the cause of the so-called painful heel.

DIFFERENTIAL DIAGNOSIS OF BONE PAIN

Bone pain should be differentiated from that due to bursitis, in which a painful swelling is located over the site of a bursa. Pain is present only in acute bursitis. In the chronic form it is absent unless an acute process is engrafted upon the chronic one. Of somewhat frequent occurrence are the neurotic ostalgias, the so-called functional pains. In some cases the diagnosis from the organic form of pain is very difficult, but on examining under anesthesia in those suffering from neurotic ostalgia no loss of function is apparent and no abnormal change in the tissues can be felt. An X-ray examination also shows no pathological change; at the same time there is no definable change in the relationship of the bone to the surrounding parts.

Hysteria may be differentiated by associated areas of anesthesia and hyperesthesia, as well as by the eye symptoms. Nerve lesions, such as neuralgia and neuritis, are distinguished by their characteristic symptoms. Referred nerve pain is sometimes present in a bone, but this is not so difficult to diagnose. Local symptoms of disease are absent, while diseased nerves are present at a distance. Pains may also be referred from a bone to a distance; such pains referred are often found in diseases of the vertebræ, however, in which case pressure over the spinal column is very painful.

JOINT PAINS—ARTHRALGIA

Classification. Joint pains are of two classes: organic, in which the pains are due to structural changes; and nonorganic, in which no apparent structural change can be found. In the former the pain appears when the affected organ begins to function. Under the latter class are included the hysterical and functional pains.

Organic joint pains may be due to injury or to disease of any one or more of the following structures: namely, the bone, cartilage, synovia, capsules, muscles, tendons, subcutaneous tissues, and the skin. The pain in the bone may be due to involvement of the epiphysis, in which case it is elicited by direct pressure over the epiphysis. On the other hand if the articular cartilage is diseased the pain is best elicited by suddenly jolting the articular cartilages one against the other. If pain is present from the onset of the swelling in a moderately enlarged joint, and then if a sudden enlargement of the joint occurs, with a concomitant increase of the pain, the condition is most likely a chronic arthritis, with an acute reinfection and consequent synovitis. If such is the case, it is accompanied by the symptoms found in acute synovitis, such as a rise of temperature, chill, and marked redness of the skin. If pain and swelling are found first, in an area adjacent to

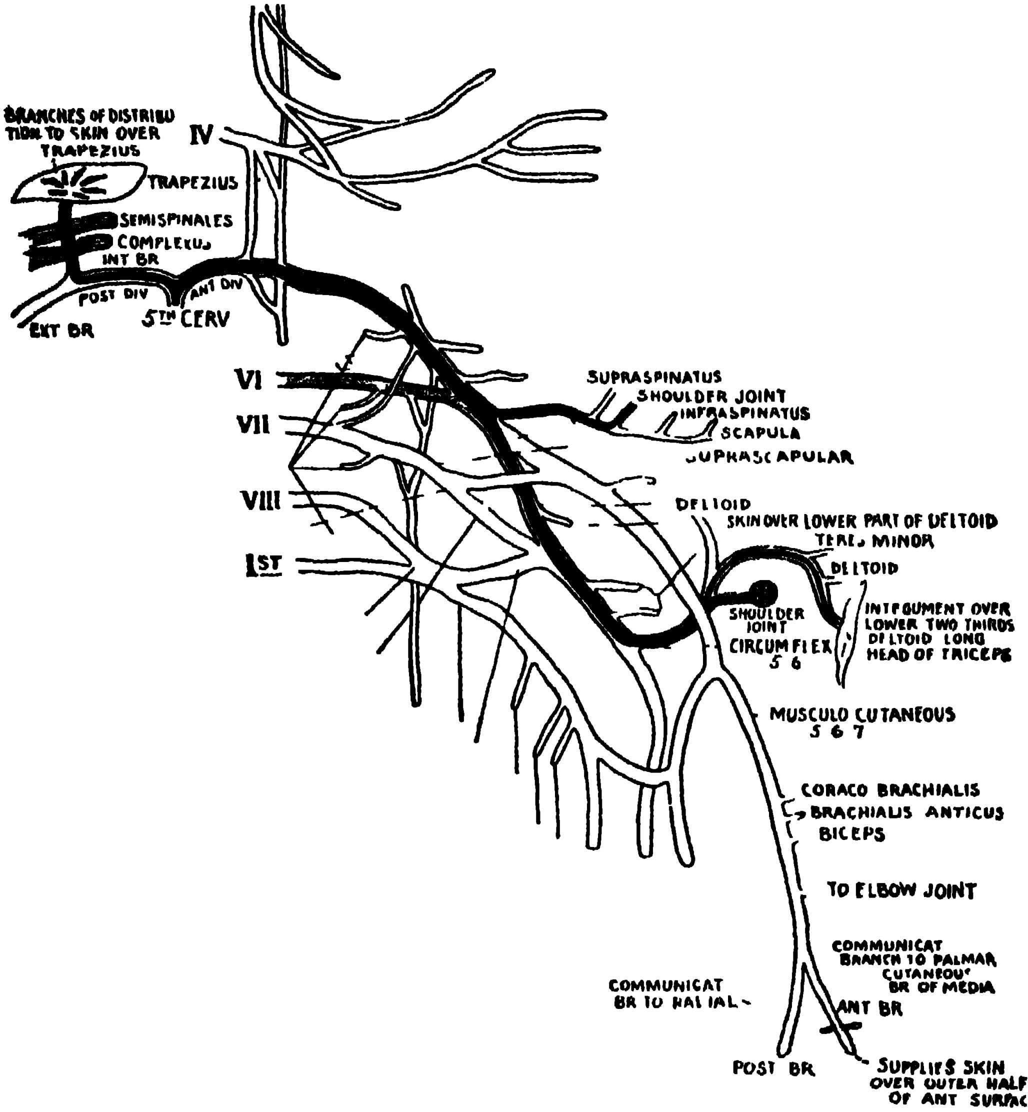

FIG. 59 —PAIN IN SKIN OVER BACK AND SHOULDER DUE TO DISEASE OF SHOULDER JOINT

In this drawing of the brachial plexus is shown how in injuries to the shoulder joint the pain may be carried back through the suprascapular and circumflex nerves to the anterior branch of the fifth cervical, where it is transferred to the posterior branch of the fifth cervical and thence is further propagated backward until it is distributed to the skin over the back (trapezius muscle)

the joint, and then spread to the joint and cause it to become very much swollen, sensitive, and tender, it indicates that an inflammatory process has extended from the adjacent tissues to the joint, causing an acute arthritis. Inflammatory processes of this nature are characteristic of extension from an osteomyelitic area in the bone into the joint, and also of an inflammation of the adjacent soft parts, such as occurs in erysipelas, abscess, lymphangitis, and bursitis with consequent extension into the joint. Osteomyelitis is tender only on deep pressure, while cutaneous and subcutaneous inflammation is exquisitely tender on superficial pressure. Inflammatory changes also give other characteristic symptoms.

Radiation of Joint Pains.—Joint pains, as a rule, do not radiate. There are few exceptions, however, as exemplified in the pain of the knee and the inner side of the leg, which occurs in the hip-joint disease, and the pain in the ankle and calf of the leg present in flat foot. Pain due to disease of the shoulder joint is sometimes felt in the skin over the back and shoulder (see Fig. 59). There may also be a radiation of pain to joints. This is found in primary or associated nervous lesions, as tabes or syringomyelia.

Intensity of the Pain.—The intensity of the pain gives some indication of the rate of development of the lesion, for it has been found that the severity of the pain depends to a great extent on the suddenness of the onset of the disease; the more acute the onset, the more severe is the pain. The reason that pain is not very severe in disease of gradual development is that, in this type of disease, the body becomes accustomed to the pathological changes, and is not so radically affected as it would be if they were of sudden origin. Therefore they do not cause such sudden readjustment of tissues and consequently do not cause much pain. When joint pains are of extremely sudden onset, they are usually the result of an acute synovitis.

Symptoms.—In involvement of a joint the pain, as a rule, is accompanied by certain more or less specific symptoms, such as muscular spasm, and swelling or loss of function of the part affected. In deep joints, as the hip, muscular spasm is the best indication of joint trouble: whereas, in superficial joints, as the knee, swelling is the surest indication.

The CESSATION OF FUNCTION in a hypersensitive joint may be explained on the following hypotheses:

(1) That a balance exists between the external muscles and the internal resistance of a joint. When the muscular action becomes excessive, and too much pressure is exerted upon the internal structures of the joint, pain is produced. This inhibits further action of these same muscles, and causes inactivity.

(2) Where excessive pressure is present, there also seems to be, according to Hilton, a lessened amount of synovial fluid, which produces more difficult movement, a tendency to pain production, and a consequent inhibition of motion.

(3) Muscles surrounding or associated with an affected or painful joint are hypersensitive, and are easily thrown into contraction, in which state they are better able to repel any attack upon the integrity of the joint. This hypersensibility also causes them to contract to a lighter stimulus than usual. In some cases the slightest touch causes the most pronounced reaction.

(4) A position of flexion is generally taken by an affected joint, because even though both the flexor and the extensor muscles are equally involved, the flexors being the stronger, overcome the weaker extensors, and draw the limb into the position of flexion. It is possible that the associated tenderness and loss of muscular power present in a limb in which the joint is diseased and painful may be explained by the association of the nerve supply of the joint with its surrounding muscles and overlying skin. From these premises Hilton has deduced the following law: The same trunk or nerves whose branches supply the groups of muscles moving a joint, furnish also a distribution of nerves to the skin over the insertion of the same muscles, and the interior of the joint receives its nerves from the same source. This law does not always apply, for it has been partially controverted by Sherrington.

After the patient has described his pain and its characteristics it is necessary to verify his statements. This is done by palpation and manipulation. Of the symptoms resulting from manipulation the most important one is TENDERNESS. In all inflamed joints this is always present It is also well to note whether the tenderness is superficial or deep. If superficial, the lesion may be in the skin, muscles (myalgia), or nerve (neuralgia), but if it is deep and is noticed only on deep palpation, it indicates that the lesion is probably associated with the bones forming the joint, or with the synovial membrane of the joint itself. Then if the tenderness is not too great, manipulation of the joint is performed (passive motion being made). Some idea of the intensity of the pain may be derived from the resistance to motion. Tenderness in a joint may also be elicited by knocking the opposing joint surfaces together with a sudden shock. If they are denuded or inflamed, pain is produced. Both of these signs can be elicited in the presence of fluid if the quantity is not too large, or if the internal tension is not too great. If still in doubt as to the origin of the pain, it is necessary (after all these diagnostic means have been exhausted) to use a so called therapeutic test. Mercury and iodin, as a rule, will cause syphilitic joint pains to cease, and salicylates ameliorate those due to rheumatism.

Of the symptoms associated with pain in joint disease SWELLING of the joint and REDNESS are the most important. Redness usually is associated only with acute processes, which may be of two kinds: (1) *traumatic* in which, in addition to swelling of the joint there is present a history of an injury; (2) *infectious,* when infection is added to traumatism, the pain and swelling increase and fever makes its appearance. If, following traumatism, there occur in a joint pain and swelling, it indicates that an acute synovitis has developed. If fever is also present, infection should be thought of, and septic organisms should be sought. In cases of subacute urethritis, the gonococcus is a frequent cause of joint involvement. However, gonorrheal arthritis should always be considered in case of an apparent idiosyncratic inflammation in the joint, when it is borne in mind that septic involvement of a joint, without external communicating injury, is very rare, and that when, in the presence of gonorrhea, joint involvement occurs, the gonococcus is probably the causal agent. In gonorrheal arthritis the pain is slight at first, and is accompanied by swelling and stiffness of the joint, with a slight temperature. A history of such joint difficulty may also show that the joint symptoms followed the passage of a sound.

Eisendrath gives the order of frequency of involvement of the joints in eight hundred and fifty-five cases of gonorrheal joints, as follows: In the knee, in 158 cases; in the ankle, in 125 cases; in the wrist, in 76 cases; in the elbow, in 53 cases; in the shoulder, in 44 cases; in the hip, in 42 cases; in the temporo-maxillary, in 16 cases; in the small joints of the foot, in 16 cases; in the heel and toes, in 21 cases; in the small joints of the hands, in 50 cases, and in other articulations, in 24 cases.

Diagnosis of Inflammatory Joint Pains. SEPTIC.—All inflammations of a joint are not septic. The presence or absence of infection may be denoted by the temperature of the patient. Fever, as a rule, is an indication of infection. Where infection is present, either rheumatic or septic, the original site of entrance should be sought. In rheumatism it frequently is the tonsils; in gonorrhea, the urethra; in sepsis, the endometrium. Less frequently the infection may originate from typhoid fever, meningitis, and pneumonia.

If the inflammation of the joint is NON SEPTIC and fever is absent, the metabolic and eliminating organs of the body should be examined. Pain and redness of a joint are very common in lead poisoning, joint disorders accompanying psoriasis and in the so-called uric acid diathesis, the sodium urate deposits in the joint causing pain. In children scurvy is a frequent cause of joint disturbance. In a suspected case of rickets the gums should be examined for sponginess, and the body for the hemorrhagic skin eruptions which are so characteristic of this disease.

In *rheumatic inflammation* the pain is most severe, and is accompanied by an excessive degree of joint swelling. If cardiac involvement is also present, and a rapid amelioration takes place under the use of salicylates, the diagnosis is rendered certain. Should redness be absent and temperature little marked, tuberculosis may be present. Tuberculosis of a joint (especially of the knee) is frequently present without redness, and in many cases without pain. A tuberculin reaction or tuberculous foci elsewhere in the body would aid in clearing the diagnosis.

Acute synovitis is characterized by chills, swelling, tenderness, loss of motion and redness of the overlying skin. Stiffness is a frequent sequela of synovitis. When it occurs, pain on motion is excessive. Stiffness with pain may also be the result of immobilization for long periods.

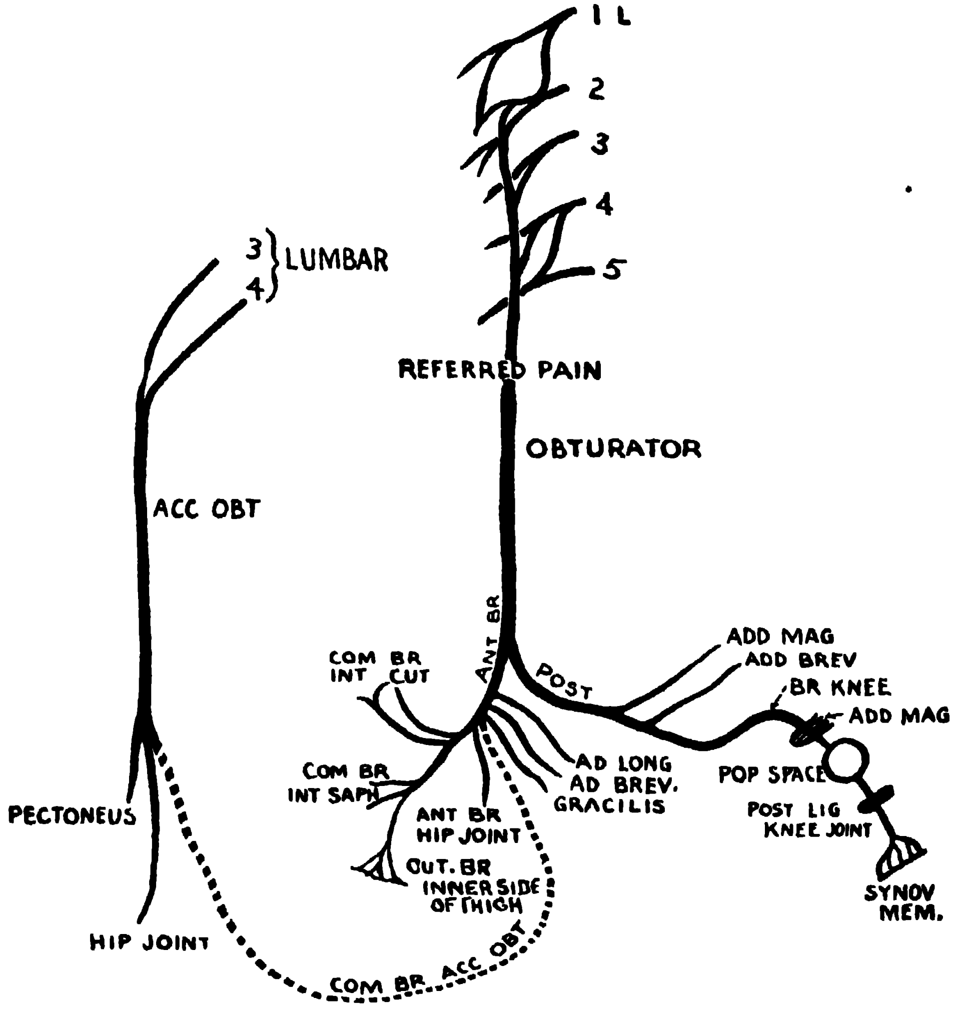

Fig. 60.—Obturator and Accessory Obturator.
This shows the relation of different thigh muscles to the hip joint.

Hip Joint.[1] In diseases of the hip joint, we have occasion to observe many different forms of pain, the varieties of which doubtless depend upon the peculiar relationship of the nerves to the joint. The nerves of the hip joint are mostly derived from the lumbar plexus. They are: (1) a median skin branch from the femoral nerve, and (2) the obturator nerve, which through its posterior branch supplies the anterior and median parts of the capsule, and through other branches supplies the intraarticular ligament and the acetabulum. Many other nerves reach the hip joint, either by way of the nervus ischiaticus or the quadratus femoris from the sacral plexus.

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[1] By Dr. Werndorf, Assistant to Professor Lorenz, in Vienna.

RADIATING PAINS. The pains observed in the hip joint are, for the most part, either radiating or local. Radiating pains are observed in the early stages of all classes of hip-joint disease. They are frequently the first signs of the so called voluntary lameness, and are also an early symptom of beginning tuberculous disease of the hip. They are also observed in acute and chronic inflammations of the hip joint, and in growing joints. The most frequent point of radiation is the knee. It is very probable that the pains propagated to the knee arise through suffusion into the obturator nerve, which runs in the immediate neighborhood of the joint. Indeed, the pathology of the hip joint offers an important point for this sort of explanation of the so called knee pains, for anatomical examinations show that the synovial form (most frequent) starts with proliferating tuberculous granulation tissue in the acetabular fossa, and also in the part of the joint cavity occupied by the intraarticular ligament. A branch of the obturator nerve, supplying the joint, accompanies the ligament and enters the joint through the incisura acetabuli. Branches from this nerve also supply the upper half of the knee joint, and the median side of the thigh, in which locations the referred pain is most frequent. Radiating pains are frequently also felt in the lower half of the knee joint, or in the popliteal space.

FUNCTIONAL PAINS. Another variety of pains observed in the hip joint, which are of great interest, are the functional pains resulting from movement and weight bearing. The principal difference between these two forms of pain has generally been overlooked. Lorenz was the first to show, on the foundation of his interference therapy, the fundamental differences between the movement and the weight-bearing pains. The so-called movement pains arise on movement of the head of the bone in the articular cavity; the weight-bearing pains, on the contrary, arise through the (functional) weight-bearing stress on the bones constituting the joint.

Movement Pains.– If a synovial diseased joint is opened, the synovial membrane is found to be considerably swollen, it being three or four times thicker than normal, and, at the same time, reddened and infiltrated. The cartilage of the head of the bone may be perfectly normal. Its shining whiteness is in striking contrast to the redness of the synovia. Now, by the least movement of the head of the femur in the acetabular cavity, the diseased, and therefore very sensitive, synovial membrane is pinched and squeezed into folds. It soon becomes injured, and this traumatism chiefly affects the numerous and multiple divisions of the nerves running in the synovia. Therefore the pain felt on movement occurs through the irritation of the intraarticular nerves of the synovial membrane. It is understood, without further explanation, that in this stage of the disease weight bearing, that is, the pressing of the head of the bone against the articular cavity, is without pain. Therefore, on examination, very often the remarkable symptom occurs that a child with coxitis walks entirely free from pain, and that, on examination of a joint previously painful on to and fro motion, the weight bearing test proves entirely negative. A light blow on the sole of the foot of the diseased and outstretched limb produces no pain, while the least attempt at movement of the thigh against the pelvis produces the most severe pain. The irritation (on movement) of the intraarticular nerves produces a reflex spasm of the muscles which surround the hip joint. The joint is at once, when fixed through the resulting muscular action, rendered free of pain, since the injury of the sensitive internal covering of the joint is prevented. So it happens that a muscular fixed joint is insensitive against weight bearing, while for the same reason night cries are a constant symptom in the history of a coxitis patient. In sleep the muscular spasm which fixes the hip joint relaxes, and with it the fixation of the synovial membrane disappears and any involuntary movement of the patient produces the greatest pain. He is aroused from sleep by the pains. The muscular spasms recur, and again protect the joint from painful movement, so that the patient again falls to sleep.

Should any doubt remain as to the truth of this explanation of the causation of these pains, it will disappear on viewing the results of treatment by early fixation by means of a plaster cast.

The plaster cast takes the role of the fixating muscles, and the joint will remain insensitive to weight bearing, so insensitive that the coxitis patient is able to walk on his diseased limb, and frequently can even jump on it without producing pain.

Weight-bearing Pains - The pains observed on allowing the hip joint to bear weight are of an entirely different kind. They are mostly local, are seldom radiating, and disappear if the patient rests in bed. Movement of the thigh of the diseased side against the fixed pelvis produces no noticeable increase of the pains. They arise through traumatism of the ligaments and muscles, as the result of a changed direction of weight bearing. Therefore, they are almost always observed when adduction and flexion contractions are present in the hip. When, as may frequently be observed, a genu valgum, or recurvatum occurs in addition to the adduction flexion contraction, weight-bearing pains are present in the knee joint. They are similar to the pains arising from static deformities, and can be well differentiated from the radiating pains previously mentioned. Trauma of the soft parts of the joint is caused by the stretching of the muscles and tendons on the adduction side of the joint. The bony structural inhibition itself produces very little pain, except when destruction of the joint itself is present.

Physiological investigation (Dubois Raymond) has shown that equilibrium in walking and standing occurs not so much through the action of the bony elements of the joint as through the play of musculature related to the joint and the tension of the ligaments. The knowledge of these facts is of the greatest value in the treatment of a tuberculous hip joint, for it shows us that a hip joint, once fixed and therefore protected against joint movement, may be subjected to weight bearing. The functional irritation (friction) of the weight-bearing is suitable to stimulate the end of the bone to grow, and in this way to produce an ankylosis of the hip joint, which is the object sought.

Tension Pain of Intraarticular Hip-joint Abscess.—Besides movement and weight-bearing pains, we recognize in the hip joint an especial form of pain which has been observed exclusively in intraarticular abscess of this joint. It is classified as tension pain, and is produced through the progressive hypertension of the joint capsule, due to an increase in the intraarticular pressure. The pain, for this reason, may be almost unbearable. The weight-bearing pains are felt especially on walking, and the movement pains are elicited on gross movements of the joint; and while in both many intervals of rest are granted to the patient, the pain of intraarticular abscess is continuous. Pressure of the bed clothes alone often causes intolerable pain; and, as a rule, a child with an intraarticular abscess cries and screams incessantly. The tension pains of an intraarticular abscess defy every form of mechanical treatment, and it is precisely this negative result of an otherwise efficient therapy which gives very frequently an important point for the diagnosis of an intraarticular abscess. However, the greatest difficulty underlies the diagnosis, especially of a beginning intraarticular abscess. One is unable to determine the presence of fluid in the joint, owing to the cavity of the hip joint being very slight, and because the thick, muscular infundibulum surrounding the joint makes it inaccessible to the sense of touch. Fluctuation is felt only after the abscess has penetrated the capsule and has become extraarticular.

The diagnosis, however, can be made by close attention. A coxitis patient who has been treated a short time with mechanical treatment, that is, with the plaster trousers or the so-called combined bandage (Lorenz plaster hose with leg apparatus), may remain for a short time without pain. He then commences to cry out a couple of times in the night, but by day he is usually free of pain. In a few days painful attacks occur also in the daytime; the night cries become more frequent, and in a short time the pains are continuous, so that the patient presents a picture of the greatest distress. In spite of all the bandages, the pains increase, and evening fever sets in. This condition persists many weeks with a constantly increasing severity, until suddenly, over night, the pains entirely cease, and the very sick patient appears again as though given back to life. The intraarticular abscess has broken through and has become extraarticular, and will, finally, be palpable as a subcutaneous abscess.

A little trick, which is suitable to establish objectively a beginning intraarticular abscess, may be brought into play. With the patient in an abdominal posture, normally, the medium-size trochanter can be touched in a small depression corresponding to the retrochanteric fossa. This part of the posterior and upper surface of the neck and of the femur is not normally inclosed by the joint capsule, but in the early stages of an intraarticular collection of fluid, the dilated capsule is swollen and covers the otherwise free and extraarticular part of the posterior part of the neck of the femur, so that, by close investigation, a circumscribed fluctuation may at this point be determined.

The knowledge of the beginning of an intraarticular abscess is, therefore, of a significance not to be depreciated, because in a positive diagnosis the early opening of the joint (arthrotomy) relieves the patient with one stroke from all his suffering.

According to William Bruce (*Scottish Med. and Surg. Jour.*, 1904, XIV, 297-304), gouty deposits may occur in the hip joint. These, he claims, irritate the articular (nerve) branch which, arising from the fourth, fifth L. and first S. segments, causes irritation to these segments, and gives rise to pain, referred to the areas of distribution of the sensory nerves derived from them. These areas of distribution almost coincide with the area of distribution of the pain in cases of sciatica. He differentiates the gouty joint from sciatica, however, in that, in this condition: (1) There is a wasting of the gluteal muscles. This is absent in sciatica, because these muscles are not supplied by the sciatic nerve. (2) In a gouty hip joint there will also be noted impairment of motion—also (very frequently) a grating and roughness on movement.

*(3) There is also lameness of the hip and (4) tenderness to pressure over the hip joint. Both of these are absent in sciatica. These considerations also hold true for an arthritis deformans of the hip. In all cases, however, an X-ray picture should be taken, and the diagnosis made certain

CHAPTER XII

THE CIRCULATORY SYSTEM

The circulatory system consists of the heart, the arteries, capillaries, and the veins. The heart is considered under its appropriate heading (q. v.). At the present time we shall consider the blood vessels (arteries and veins). The capillaries can hardly be said to cause pain, except possibly in inflammatory states, where undoubtedly they have a slight influence in giving rise to the throbbing pain felt in those conditions.

PAIN CAUSED BY CHANGES IN THE BLOOD SUPPLY

In circulatory disturbances, pain is produced either by a too great (disproportionate) increase or decrease in the blood supply. When the blood is increased in quantity, congestion results, and pressure is made upon the terminal filaments. This congestion is of two varieties, namely, active and passive. The active variety has been considered under inflammatory pain. The passive variety (passive congestion) we will now consider.

Pains from Increase in Blood Supply.—First of all, what is meant by passive congestion? By this, we here understand a condition in which there is an excess of blood in a part, due to backward pressure. This pressure can never become excessive; so that the most to be expected in this condition is pain of a dull, aching character. This pain is always felt directly in the congested area or is referred to the skin region associated with the congested organ. In static congestion a part of the pain undoubtedly is due also to toxic products, which must, of necessity, accumulate in the tissue when the exit from the affected part is obstructed. Such stasis pains are produced in the liver and spleen when the right heart circulation fails. These are probably the two best examples of this condition, because in both cases inflammation can be absolutely excluded. The cause of the pain is the stretching of the capsule of these organs, with possibly, at the same time, some pull and drag on the ligaments. Of course, as a cause of passive obstruction, tumors or displaced organs pressing upon the returning veins must not be forgotten.

Pains from Diminution in Blood Supply. — A diminution of the blood supply to a part causes pain by the starvation of the tissues which results; and, as the nervous tissues are by far the most sensitive, disturbance in them is first produced, and sudden, sharp pain is produced. This is well illustrated in RAYNAUD'S DISEASE, the symptoms of which are due to a contraction of the smaller arterioles in an extremity (generally the hand). In this disease sudden, sharp pain occurs in an extremity, increasing with the elevation of the part. The surface is cool and white, and sensation is diminished, the part being numb to the touch. This symptom complex appears (and disappears) at irregular intervals, until finally a small, atrophic ulcer develops on the most distal part of the limb affected. This may progress upward, or a portion of a finger or toe may become gangrenous. In other cases the primary contraction is followed by a dilatation of the vessels, and the part becomes swollen and purple (Sachs, 622). In these cases, when the limb is elevated, the pain, which is of a drawing, burning type, disappears. Raynaud's disease—which is, after all, a fairly ample syndrome is in reality a dual affair. The cells in the spinal cord, usually termed sympathetic and trophic, and regulating the vessels, are those primarily affected. The pains are largely due to implication of this system of nerves, and are grouped by Head with the general group of protopathic and deep sensibility pains. Buerger has recently described a state in which the arteries of the lower limbs become thrombosed or obliterated (endarteritis obliterans. See intermittent claudication.). Here the pain is most intense and is constant while the limb is dependent, but disappears on the elevation of the limb. No medicinal treatment can alleviate the pain of the unfortunate sufferer, and the only means of easing his agony is high amputation of the diseased limb. This condition has been called thrombo-endarteritis obliterans.

In PURPURA HÆMORRHAGICA the pain is also caused by obstruction to the onward circulation. The cause can be explained more explicitly if we examine the cause of the hemorrhage in a case of purpura hæmorrhagica due to syphilis (reported by Sabrazès and Duperin, 573). In this case the hemorrhages were due to the rupture of capillaries, due to mechanical obstruction by the intestinal granulomatous lesions of the disease. These lesions will explain the pain felt in these conditions, for it is a noticeable fact that the pain, not only in this, but in most rheumatic purpuras,[1] is very great until the hemorrhage appears, when it is eased. In other words, during the period of distention of the vessel, there is pain, while on rupture and removal of the intra-arterial tension the pain disappears. In any case, when an artery is affected, the pain follows the distribution area of the affected artery.

FUNCTIONAL ACTIVITY, because of the increased demand made upon the arterial system, often causes severe pain when the blood supply to the active part is deficient. This is illustrated in cases of aortitis, stenosis of the coronaries, passive congestion of the liver and spleen, and in arteriosclerosis of the mesenteric vessels.

ARTERIAL DISEASES CAUSING PAIN

The principal arterial diseases causing pain are arteritis, thrombosis, embolism and aneurysm. It has been claimed by Granville that the vasomotor nerves have a component of sensory fibers. Should such be the case, one can easily understand why, in disturbances of the vessels, pain should result. That a complement of sensory fibers accompany vasomotor nerves may in part be true, for in performing abdominal operations under a local anesthetic, it has been found that the ligating of vessels is very painful. Yet it seems that, in most cases, especially in the presence of inflammation of the vessels, the pain is due to the inflammation which has extended to the adjacent nerves. This has been set forth by Buch as the cause of pain in aortitis.

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[1] I am not aware of any work done as yet which would prove that the cause of obstruction of the vessels in purpura hæmorrhagica is either emboli or thrombi, but reasoning from analogy such would seem to be the case

Inflammation.—When inflammation occurs in an artery the tima is the part first affected. Up to this point no pain results; then the inflammation spreads to the media, and finally to the adventitia, in which it seems that the receptors for pain sensibility may lie. The arteries of smaller caliber are not as sensitive as the larger ones. Perhaps the best place to study arterial changes and the sensory results is in the aorta. Here the inflammation, as long as it remains in the aorta, produces no pain, but it soon passes out and involves the neighboring cords of the sympathetic. Ordinarily the sympathetic is not painful, but, according to Buch (171), Wutzler, Flourens, Bruchet, Valentin, and Longet have found that the sympathetic becomes sensitive through inflammation or congestion. Confirmation of the fact that inflammation may be communicated to the sympathetic from an aortitis can be found in the writings of Debove and Letulle (381), Rigal and Juhel-Rinon (385), Weber (386), Lanceraux (387), Dutil and Launy (388), Lapinsky (389), Duplaix (390), and Holsti (391), who have found that inflammation of the aorta was communicated through the adventitial coat to the aortic and celiac plexus. Buch agrees with these observers, and discredits the view of Potain (380) that the pain is due to inflammation of the arterial wall. Engleman (381), like the previous observers, believes that the pain is due to hyperalgia of the aortic plexus. Buch (p. 291), in affirming these views, claims that he not only has found the aorta hyperalgesic, but also the two bordering sympathetic cords, or at least one of them.

The pain of aortitis is sudden in onset, occurs in the epigastrium, and resembles angina pectoris in its severity and suddenness. It is produced by exertion and by the ingestion of food, the kind seeming not to be so important as the quantity. The pain comes on in paroxysms, each individual paroxysm lasting only a few minutes. Paroxysms seem to be especially produced by elevation of the arterial pressure, particularly when it is accompanied by contraction of the superficial vessels. A cause of this contraction may be excessive functioning of the suprarenals (Buch). In this relation it seems that when the blood is thrown into the deeper vessels because of their stiffness they are unable to dilate and accommodate it. As a consequence, congestion of the sympathetic occurs. This gives rise to pain, because of its previous irritability. A reflex dilatation of the vessels then takes place, change of the blood flow occurs, and the congestion and pain are relieved. It is characteristic of these cases that the pain is relieved by strophanthus or diuretin.

The time of onset is variable, and often seems to be the result of exertion. Yet exertion is not the cause, in all cases, for, in some instances, the pain appears in the middle of the night while the patient is sleeping quietly. The position of the body of the patient seems to make a difference only in an individual case. With some, the pain comes on when they are standing, while with others it appears when they are lying down (Brunton, 11). Kreuzfuchs (572) claims that the pain is most liable to develop when the patient is lying down. Brunton calls attention to the distention of the bowel with flatus, which frequently comes on some time during the attack. During the attack tenderness of the aorta and neighboring nerve trunks is present, and, according to Brooks (93, p. 784), persists for some time afterward.

In some cases, as related by Rossbach (623), symptoms of gastric disturbances may be present for years without a typical attack. These are the cases which are frequently diagnosed as stomach disorders. Arteriosclerosis of the aorta seems to be more common in men than in women, and most frequent in the years from forty to fifty.

Increase of Blood Pressure. That increase of blood pressure alone may cause pain is affirmed by Pal (671) who, in examining cases of lead colic, found the blood pressure in the intestinal vessels increased from one half to twice the normal pressure. This increased pressure irritates the terminal nerve filaments, or reduces the circulation in the intestine, thus causing pain.

Intermittent Claudication. There is a peculiar and comparatively rare condition, especially frequent in male Russian

Hebrews, in which pain in the lower limbs is associated with vascular alterations. It was first described by Charcot. There is, in this disorder, a sensation of numbness, fatigue and pain, which comes on in one or both legs on walking. It increases in severity after a short time fifteen minutes to half an hour—and renders locomotion impossible. On resting, the pain disappears, to appear again after walking. In advanced cases the pains occur spontaneously, from time to time, or they are persistent.

The pains resemble those of a sciatica, although they are apt to be more diffuse, involving the entire calf, or thigh, rather than following a nerve trunk. Cyanosis, pallor and coldness are frequent accompanying symptoms. They can be induced by having the patient walk briskly, when the sole of the foot will be observed to be waxy and cold. The absence of pulsation in the dorsalis pedis and posterior tibial arteries is a marked feature of many cases. Arteriosclerosis is a constant accompaniment, and X-ray examinations of the legs will often show the presence of hardened calcified blood vessels. An obliterating arteritis alters the nutrition of the muscles and may be the cause of the pain on walking.

At times a spastic vascular condition may rest at the bottom of the disorder without any pronounced organic vascular lesions, although these are probably early cases. It may also be due to congenitally small blood vessels. In the majority of these cases the organic vascular changes come along later.

An intermittent claudication of the arm may be present.

Erythromelalgia. Here the chief features are pain and redness of the skin, particularly of the feet, less often of the hands, still more rarely of all four extremities. Pain is an early sign. It comes on after over exertion, and is usually abrupt in onset, although occasionally gradual in its development. The balls of the toes and the heels are the sites of maximum involvement. Rarely the whole extremity, upper or lower, is invaded. There is, in addition to the pain, redness, and the tips of the fingers or toes are swollen. There is a sensation of exquisite pain, with burning, and, as a matter of fact, the local temperature is raised. The blood vessels pulsate, small nodules appear, and marked sweating is apparent. Other sensory changes are slight, and consist of a mild hyperesthesia or hypesthesia.

The pain varies. In the more advanced cases it is severe torture, but may vary from a mild discomfort to agonizing pain. Cold and the recumbent posture relieve it, while lowering the affected part, standing or walking (if the feet are affected), or the application of heat, increase its severity. On walking (feet being affected), the swelling is increased, and the redness becomes successively more marked.

This condition is probably more than a single entity, since it may be associated with disease of the sympathetic cells (in the cord), or with disease of the peripheral nerves. Again it is allied with vascular disorders. It is probably a vasomotor neurosis of central origin.

Embolism and Thrombosis of the Mesenteric Arteries.—The mesenteric arteries merit separate consideration; and it is especially necessary to review the two most important causes of pain in lesions of these vessels, namely, thrombosis and embolism.

In both of these conditions the blood supply to the intestine is cut off and paralysis (absence of peristalsis) occurs in the affected segment of the bowel. This paralyzed bowel acts as a barrier to the forward movement of the feces, and all the signs and symptoms of obstruction take place. In embolism these symptoms are, as a rule, sudden in onset, while in thrombosis they develop more slowly. As in intestinal obstruction from other causes, generally the first sign of the disease is pain, which is sudden, sharp, acute, and is referred to the epigastrium, if the superior mesenteric artery is affected, while if the inferior is the one involved, the pain is referred to the region of the abdomen, below the umbilicus. Shock is a constant symptom, accompanying the pain. After the first acute pain, there is often a lulling of the pain-sensation, but the pulse continues rapid (the effect of the shock). In a short time the pain again becomes prominent, and is of a colicky character. The primary pain is regarded as due to the sudden shock to the mesenteric nerves, the secondary as due to the pull and drag upon the mesentery. As soon as the segmental bowel paralysis becomes complete, signs of obstruction, such as vomiting, intervene. The vomitus consists, at first, of the contents of the stomach; later, of the bowel down to the point where the obstruction has occurred. The bowel movements at this time often contain blood, which is bright scarlet and somewhat fluid, in obstruction of the inferior mesenteric. It is dark in color and somewhat clotted in lesions of the superior mesenteric artery. A tumor composed of gas also makes its appearance in the abdomen. This tumor is generally more marked on the left side in lesions of the superior mesenteric, while in lesions of the inferior mesenteric it is more marked on the right side and across the abdomen. This tumor mass quickly becomes of great extent and soon occupies the entire abdomen. At the same time a transudation takes place and on celiotomy a bloody peritoneal fluid is found. Should the obstruction be more gradual, such as occurs from an arteriosclerosis, pain is a marked symptom. It is not constant but is of a flitting character, such as we find present in another location in angina pectoris. Pain of this character, without any well defined, apparent pathology, should always cause us to examine the arterial system for arteriosclerosis.

Aneurysm. When the coats of an artery are abnormally dilated singly or *en masse* we have a condition called aneurysm. In this the pain is constant and gnawing as a rule. In some cases it is paroxysmal though often in the early stages of aneurysm it may be entirely absent. In many cases the patient localizes the pain over the tumor mass by pressing over the affected area with his hand, and a characteristic of the disease is that deep pressure is always very grateful. Should any sensory nerves be pressed upon by the tumor mass pain is referred to their peripheral distributions. These referred pains vary with the situation of the tumor. When the arch of the aorta is involved, the local pain is felt to the right of the sternum at about the junction of the second or third rib with the sternum and the referred pain is felt in the inner side of the right arm and extends as far down as the elbow. Frequently in an aneurysm of the thoracic aorta the pain does not follow the distribution of the intercostal nerves, but is located over the back in the distribution area of the spinal nerves. It may also radiate into the left shoulder and arm. The aneurysms of the thoracic aorta, however, do not produce as much pain as do those of the abdominal aorta. In this latter pain is very severe, and is felt in the back, as a rule. At first it is somewhat paroxysmal, and then takes on a dull, boring character. When this occurs, the diagnosis of bony involvement may be made with absolute certainty. Certain positions, namely, those in which pressure is made upon the vertebræ, cause extreme, almost unbearable, pain. Hyperalgesia, corresponding to Head's zones, is often present. These areas of hyperalgesia should be carefully sought for and mapped out. In all cases of suspected aneurysm careful inquiry should be made as to the presence of pain, because the patient frequently neglects to mention it.

DISEASES OF THE VEINS CAUSING PAIN

The lesions of the veins causing pain are inflammation, thrombosis and varices.

Inflammation of the Veins. Inflammation of the veins (phlebitis) causes a very severe pain, which is more likely due to an associated involvement of the surrounding tissues than to the inflammation in the vein itself. Nevertheless, irrespective of the cause, the pain is most severe, constant and aching in character, and is greatest when the limb is in the dependent position. The pain is increased by pressure. By means of the tenderness on pressure, the entire distribution area of the vein can be defined. Phlebitis is very common in the femoral distribution following child-birth, during which a slight infection of the iliac vein has taken place. It is also very frequent in the femoral veins following typhoid fever. When so affected, the patient voluntarily lies still, because the pain is increased by the slightest movement. The condition persists for a varying period of time, and then disappears, although slight soreness lasts for some time. In some cases of phlebitis, the pain is referred to distant areas. This is due either to pressure on an adjacent nerve by the inflamed vein, or to a communicated infection. In cases of pressure or inflammation of the sciatic, or of the lumbosacral cord, the pain is referred into the area of distribution of the sciatic (Peterson, 625). It is most intractable, and is curable only on the amelioration of the causative lesion.

Thrombosis Since thrombosis of a vein is, in nearly all cases, nothing more than an inflammatory process, the above description of phlebitis will equally well apply to it.

Varicose Veins. Of varicosities it is only necessary to speak of those of the lower extremities. Varicosities in other regions are entirely, or almost entirely, painless. When varicosities occur in the lower extremities, the external and internal saphenous are the veins principally affected, and it seems that the internal is, as a rule, more severely involved than the external. Consequently, the local symptoms will be more marked on the inner than on the outer side of the leg. This agrees well with the histories, for most of the patients complain of pain beginning above the knee and running around to the inner side of the leg, thence down on the posterior surface of the calf, extending, in some cases, even as far as the ball of the foot. Usually the pain is worse at night. During the day the patient, as a rule, has been standing on his feet more or less, and a certain amount of inflammatory congestion results from this. In many cases of varicosities of the internal saphenous if pressure be made on the anterior crural, pain radiating into the inner half of the thigh and the leg will be felt. After the formation of an ulcer, the pains are very severe, and make the patient's life miserable. They are eased by the application of firm pressure, which would seem to indicate that they are due either to traction from the excessive granulations, which, when filled, drag upon and stretch the terminal nerve filaments, or to exposure of the nerve endings in the floor of the ulcer, which follows upon the removal of the ordinary protective layers of the skin. In any case the pain is extremely severe and is much worse when the limbs are in a dependent position.

CHAPTER XIII

THE GLANDULAR TISSUES

The Glands.—The principal glandular structures are the glands with ducts, as the mammary and those found in the alimentary tract (salivary, pancreas), and those without a duct, the so-called ductless glands, as the lymphatic glands, the thymus, thyroid, pituitary and the adrenals. There are also numerous small secreting glands found in the mucous lining of the alimentary, respiratory and genitourinary systems, but these are of such minor importance that they do not merit a consideration. When pain is located in a glandular structure, it is due, as a rule, to distention of the capsule of the gland. This distention, in its turn, is usually the result of inflammation.

In those cases in which distention has occurred gradually pain may be absent. As a rule, it is present only when the distention is acute. The pain of large, glandular abscesses or of tumors of the glands is further increased by the pressure of the tumor mass upon adjacent organs or nerves. In case of pressure upon nerves, the pain is referred, as a rule, to the peripheral distribution area of the nerve or nerves involved.

A special consideration of the most important of the glandular structures is in order. We shall commence with the mammary gland, after which we shall consider the adrenals, mesenteric, thymus, and thyroid.

The Mammary Gland.—The mammary gland is situated in the lower part of the anterior lateral surface of the thorax. The sensory receptors of the gland are found in the alveoli, from which the fibers collect to ultimately join the fourth, fifth and sixth intercostals, in which they run to the cord. The sympathetic associations are with the thoracic branches. The skin over the gland receives its nerve supply from: (1) the supraclavicular branches of the cervical plexus, and (2) the anterior and lateral cutaneous branches of the second to the fifth intercostals.

Pains in the breast may occur at certain physiological periods of a woman's life, such as in infancy (shortly after birth), puberty, during menstruation, and at the beginning of pregnancy. These pains may be pure reflex, or rather transferred, pains, and are probably due to stimuli carried through the nervous system, probably by the same well-defined paths through which other stimuli are carried when, in pregnancy, the breast begins to perform its function, and lactation commences. It is a moot question whether there is, or is not, objective cause for this phenomenon, for it seems that the stimuli transferred to the breast from the genital organs cause some slight tumescence in the breast, probably enough to produce a subjective sensation of pain, but not enough to be perceived objectively. A peculiar thing about this pain, which seems to verify its nervous genesis, is that it may be spread over a wide area, so that it sometimes involves the side of the thorax and the arm. This might be accounted for by the overflow phenomenon which has been described in a previous chapter. The intensity of the pain varies from a slight, hardly noticeable sensation, to one of most intense distress. The hyperalgia is not always confined to one breast, but may involve both. In the newly-born infant, an inflammatory change sometimes occurs in the breast. This is probably painful, but we have no means of drawing positive conclusions. (See Uterus and Mammary Pain in Uterine Disease.)

Pain in the breast may be due to the following pathologic causes:

(1) Inflammation: (a) lactation mastitis; (b) stagnation mastitis; (c) pyogenic mastitis (extension from neighboring structures, lymphatics, blood); (d) small abscesses which form in the areola from a fissured nipple.

(2) New growths: (a) malignant, as in carcinoma and sar-

[illegible] (pain and tenderness are not marked, but may be present periodically); (b) benign, as fibroids.

Tumors of the breast, as a rule, do not give rise to referred pain. Fissure of the nipple is very painful, the same as is a fissure at any of the other openings of the body; for example, the anus, the mouth, or the urethra. Simple cysts of the breast generally give rise to considerable pain, especially if they are of rapid growth.

Most of the pain produced by mammary changes is local, but retention of milk, suckling (forcible), and pulling on the nipple often give rise to referred pain in the area of the fourth and fifth dorsal segment. It seems to be an invariable rule that traction upon the nipple produces pain over the angle of the scapula posteriorly. Sometimes it is referred along the side to the anterior part of the chest, and is felt beneath the breast.

Pain and discomfort during menstrual periods should cause the diagnosis to lean toward mastitis. Carcinoma in the early stages is generally not tender, while mastitis, as a general rule, is tender.

The breast may also be subject to referred pain from the female sexual organs, for which see p. 715.

The Adrenals.- The most common, in fact the only, condition in the adrenals which we are sure of as a cause of pain is hemorrhage. The hemorrhage comes on suddenly and causes a great distention of the capsule of the gland. This, of course, produces pain, sudden in onset, and most intense. It is, as a rule, localized in the epigastrium, but may radiate to the hypochondrium, or to the lower abdomen. Digestive disturbances in the form of persistent vomiting and diarrhea are associated with this pain, while at the same time a fall of blood pressure, rapid, weak pulse, and reduction in temperature occur. The skin gradually assumes a yellowish or brownish color. Debility, coma and death finally ensue. In regard to the debility, Murdock (627), quoting from Neusser, says that the "permanent sense of weakness and exhaustion, the lack of power and debility frequently present a striking contrast to the relatively good general appearance and the abun-

DISEASES OF THE BREAST

SYMPTOMS	CANCER (Carcinoma)	MASTITIS	CYST	ADENOMA	FIBROID	ABSCESS	SARCOMA
Pain	In early stages is generally absent	Generally present in all stages. Is aggravated at the time of menstruation	No pain	No pain	No pain	Pain considerable	No pain at first, but a drawing sensation
Size and shape	Generally flat. In later stages may be fungoid	Marked though ill defined swelling painful to the touch	Rounded oval growth. The size may vary from that of an almond to that of an egg	Generally rounded swelling embedded in the breast	As a rule a sharply defined tumor	Generally in the center of the breast	Generally diffuse in filtration the entire breast or considerable portion of it being hard and leathery.
Location of growth	Generally in region of the areola commences at the nipple	At a little distance from the nipple and generally beyond the areola	Generally close to nipple	Outside of the areola	Outside of the areola	At junction of areola and the remaining part of the breast	As a rule the entire breast is involved.
Discharge from nipple	May be considerable often bloody	Generally none	Slight sero sanguineous discharge	None	None	May be pus	Often serous, though none may be present
Puckers and dimples in skin	Present	Absent	Absent	Absent	Absent	Absent	May be present
Movability	Generally does not move independent of the skin. It is also commonly adherent to the pectoral fascia	Not movable	May be freely movable	Generally freely movable	May be freely movable	Non-movable	Not movable.
Nipple.. .	Generally retracted. Generally higher than on unaffected side	Generally not affected	Not affected	Not affected.	Not affected	Generally not affected.	Generally retracted.

dance of abdominal fat." On examination of the abdominal wall one is sometimes impressed with the excessive tenderness which is present.

The Mesenteric Glands.—The mesenteric glands, even though enlarged, do not of themselves cause much pain, unless the enlargement is excessive, when, by encroachment upon neighboring structures and interference with their function, they may indirectly be the cause of pain production. In tuberculosis, when the mesenteric glands reach an enormous size, the patient often complains of aching and distress, or, as frequently expressed by negro subjects, "a misery in the abdomen." This misery becomes an acute pain, should the gland, becoming degenerated and caseous, suddenly rupture and cast its contents into the peritoneal cavity. The pain now assumes the characteristics of that due to general peritoneal irritation.

The Thymus and Thyroid.—The thymus and thyroid are entirely without pain production, unless they become acutely inflamed, when pain phenomena appear. Frequently in thyroid tumors and in disease of the gland pain is felt in the occiput, in the shoulder and back of the ear, due to irritation (pressure) of the posterior auricular. In one case pain was complained of over the second dorsal spine.

In Hodgkin's disease pain in the arms is very common, because of the pressure exerted upon the nerves in the axilla. In the same way pain may be felt in the lower limbs from pressure upon the anterior crural nerve by enlarged inguinal glands.

CHAPTER XIV

REGIONAL PAINS

As an aid to a quick orientation of the cause of pain which is felt in a special area, the body may be divided into different regions, as the head, neck, arms, chest, abdomen, and the extremities. Each of these will be fully discussed under special headings, but at first a brief, general review of the different pains in these regions and their significance will be undertaken.

THE HEAD

The head is a most important localizing center for pain, for it seems that here all the aches and ills of the human body converge to bring torment and suffering to the unfortunate individual. Head pain is partially considered under headache, which includes the pains felt in the cranial part of the head, but headaches do not include face pains. These are very important, as they include one of the most sinister of all human ills, namely, trigeminal neuralgia (tic douloureux). Its pains occur in the forehead, the cheek and over the lower jaws. There are well-defined spots of maximum tenderness, which are shown in the drawings. Of other important causes of face pains, sinus disease probably ranks next. These sinus diseases include the frontal, ethmoid and antrum of Highmore. When any of these structures is affected, pain is complained of by the patient, and at the same time tenderness is marked over the diseased area. Should tenderness not be present in the area in which the patient complains of pain, it indicates that the pain is a referred pain from some distant region.

1

Status lymphaticus

2

Intestinal toxemias
Worry
Loss of sleep

3

Ovary
Typhoid
Meningitis
Tumor
Anemia
Malaria
Small pox
Influenza
Cholecystitis
Coryza
Tonsillitis
Neurasthenia
Alimentary disturbances
Rheumatism
Toxemias

4

Antrum disease
Neuralgia 2nd br 5th n
Entire scalp affected in
  Rheumatism of the occipitofrontalis
  Periostitis
  Influenza
  Growth headache

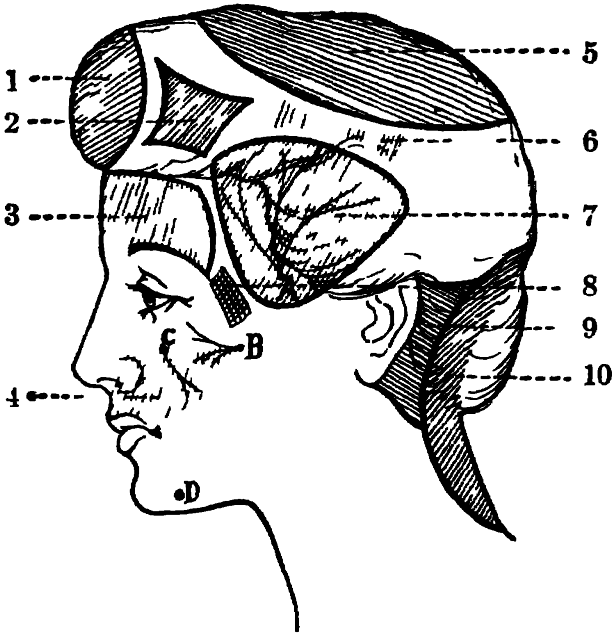

Fig 61 —Pain Areas in the Head

A Temporal branch of superior maxillary nerve B Malar branch of the same nerve Both are involved in dental caries The mental foramen is the point of maximum tenderness and the most common location of subjective pain in caries of the teeth of the lower jaw (Scholl, 123)

5

Anemia
Neurasthenia
Gout
Typhoid

6

Lithiasis

7

Typhoid
Stomach disturbances
Constipation
Neurasthenia
Dental caries
Otitis media
Disease of temporal bone
Cancer of tongue (Butler)

8

Influenza (earache)

9

Middle ear disease

10

Meningitis
Brain tumor
Gout
Neurasthenia
Nephritis
Tabes
Diabetes
Syringomyelia
Influenza
Typhoid
Uterine disease
Status lymphaticus
Gastritis
Epilepsy
Cerebellar disease
Disease of cervical vertebræ
Pharyngeal disease

A good example of this is pain in the temples, referred from carious teeth. Reference to Figures 61 and 62 will do more to localize these different pain areas and their significance than an entire volume of description. Head pains referred (reflected) from abdominal and thoracic organs are described in the chapters under their respective headings.

1

Lithemia
Anemia
Neurasthenia
Ovarian
Mental tire
Infectious diseases
  Typhoid
  Influenza
  Malaria
  Small-pox
Meningitis
Brain tumor
Coryza

2

Toothache
Supramaxillary
  inflammation

3

Neuralgia
Inf dental branch

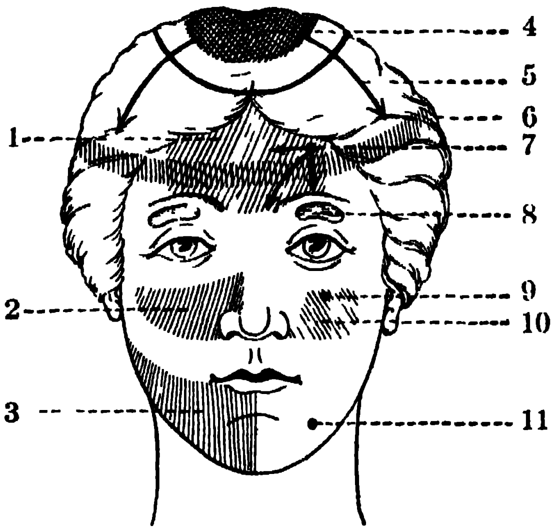

FIG. 62 -PAIN AREAS IN THE HEAD.

4
Epilepsy
Uterine disease
Pregnancy
Anemia
Meningitis
Ovarian disease
Hysteria

5
Migraine manner of radiation

6
Arteriosclerotic headache

7
Ethmoid Arrows indicate the direction of radiation

8
Orbital headache
Typhoid fever
Eyestrain
Anemia
Inflammation of eye

9
Point of tenderness in infra-orbital neuralgia

10
Antrum disease

11
Point of tenderness in mental neuralgia
Periostitis inf. max

The most important of the local head pains is headache, or, as it should be called, head pain. When a patient complains of headache, he should always be asked, "Is it a pain, or is it only a sense of pressure?" If it is a sense of pressure, the consideration will be entirely different from that of true head pain.

Sense of Pressure in Head.—Edinger has graphically discussed this condition, especially in its relation to neurasthenia. He notes that "the pressure is felt in the top of the head, and is especially severe in the morning. It generally continues all day, though it may lessen toward night. This head pressure, which is not a pain, is particularly a characteristic of tired persons; those who have overworked, either physically or mentally, and those whose hours of labor are too long or too continuous; those who are hereditarily weak; and those who have suffered from severe disease (influenza) and have exerted themselves too soon thereafter.

If the sensation is described by the patient as a pain, headaches should then be considered.

Head Pain.—In the diagnosis of headache it is well to ascertain first whether the pain is unilateral or bilateral. If it is bilateral, it generally is an indication that the underlying cause is of systemic origin, while if it is unilateral, as a rule it is an indication that the cause or causes acting to produce it are also unilateral in their origin. Where headache is unilateral, it is always wise, before making a more extended search, to examine the head for local causes, such as inflammations, or to examine the organs located in or associated with the skull, such as the eye, the ear, the nose, the teeth, and also the throat, which in many cases is at fault.

The following outline of the principal causes of head pain may be of value in the diagnosis. The classification used is based upon an anatomico-physiologic basis. According to this, head pains may be divided into two great classes: (1) those of extracranial origin, and (2) those of intracranial origin.

Head Pains of Extracranial Origin.—Extracranial head pains are caused by lesions of the skin, muscles, tendons, bones, and nerves. The *skin* includes the epidermis and subcutaneous tissues, and is the seat of pain in neuralgia and superficial inflammatory lesions. Excessive weight of hair may be the cause of severe and chronic headache.

The *muscles* are the seat of pains, the result of such metabolic disorders as occur in rheumatism, gout and diabetes. Inflammation likewise may be a cause of local pain. In this connection it is well to mention a condition described by many writers, in which headache is due to indurative processes, occurring in the muscles of the head and neck. Edinger claims that, though almost unknown, the indurative variety of head pain is probably the most common of all headaches. In those suffering from it, it is found that at the insertions, or within the bodies of the muscles of the head and neck, there appears a thickening which at first is transient and then later becomes constant. This thickening, probably of chronic inflammatory origin, irritates the sensory nerve fibers supplying the part, and thus produces pain. The pain occurs in paroxysms, which may be brought on by emotional disturbances, physical or mental fatigue, sudden exposure to cold, insufficient drying after washing the hair, a stay in badly ventilated places, and the approach of damp or chilly weather or storms. The paroxysms are least common in summer and most frequent in the fall and the spring. In the development of the induration three stages can be defined. In the first stage a swelling of a soft, yielding consistency, often present in the bodies of the muscles, makes its appearance. A puffiness to the touch is now felt at this point; then, in a short time, a slightly elastic resistance develops, as though some organization had taken place; and finally an induration, in which there is an absence of elasticity, occurs. Organization has now advanced to the stage at which a substance of cartilaginous consistency presents itself to the examiner. The older these thickenings are, the harder they become and the more resistant they are to treatment.

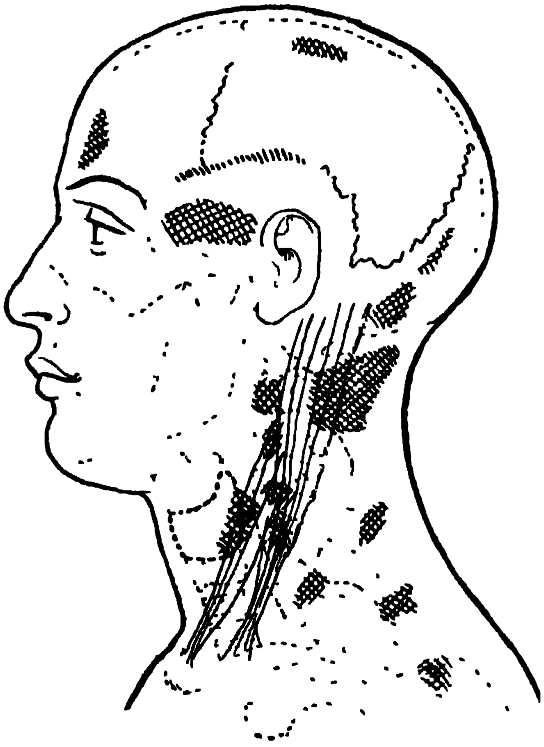

FIG. 63.—FIGURE ILLUSTRATING THE PLACES WHERE INDURATION TAKES PLACE.
These areas are tender to pressure.

The symptoms are characteristic. Attacks of pain occur, which at first are slight and infrequent, and then gradually become more frequent, greater in severity and longer in duration. Sometimes they are of a dull, aching type, and are almost constant; again, they are sharp and fleeting. They occur in various parts of the head, the location depending upon the site of the local enlargements, over which they are usually found. They may, however, radiate to other parts. Local pressure often gives relief. Before an attack the enlargements become swollen and sensitive.

The symptoms associated with this disorder are the marked susceptibility of the patient to colds, depression of spirits, and to mental torpor. Gastrointestinal disturbances, toxic in character, occur, and spasms in the leg muscles and myalgia in different parts of the body take place. Hypersensitiveness of the teeth and a pyorrhea alveolaris are also seen, and on forcible twisting or turning of the neck there is intense pain at the insertions or along the bodies of the neck muscles. Local tenderness over the sites of the enlargements almost always is present. It is most common at the insertions of the trapezii, scaleni, splenii and sternomastoid muscles. Hypersensitive points are often found round the base of the skull, from one mastoid process to the other, and on the spinous process of the cervical vertebræ, particularly the upper cervical vertebræ. The supraorbital region also is often involved.

These indurative headaches are to be diagnosed from: (1) Meningitis, in which fever is present and induration and hypersensitiveness are absent.

(2) Migraine, in which sensitive aura are present, induration and local hypersensitiveness are absent, nausea and vomiting are present, and no relief comes from massage. While hereditary migraine begins in early youth, indurative headache appears in later life.

(3) Bone diseases, such as inflammation, caries, gummata and tuberculosis should also be carefully diagnosed, as they often give rise to local head pain and indurative areas. A careful study of the general symptom-complex will often clarify the situation. As a rule, though, the indurative headaches are very common. They are very easy to differentiate, because of their local character.

That long-continued contraction of a group of head-muscles may cause pain is possible. Thompson (630) describes such headaches which arise from the long-continued contraction of the occipito frontalis muscle, as the result of a strong sensory impression, coming from the eyes, ears, or other channels of sensation. They may, however, be produced only as a result of the irritation of cold and strong winds.

Nerves. -The head pains due to nerve involvement are to be classed under neuralgias and neuritides. There is also a local irritation which has not progressed to the stage of inflammation.

Neuralgia, which means nerve pain (for a complete description see under Neuralgia), is a rather frequent cause of pain in the head. In it pressure points can be found, corresponding to the emergence of sensory nerves from the skull. The nerves most frequently involved are the trigeminal and the cervico-occipital branches of the cervical plexus. Neuralgia is frequently the result of wasting diseases, malnutrition, exposure, poor hygienic conditions, rheumatism, gout, diabetes, anemia, chronic malaria and acute infectious disease.

Neuritis, a somewhat allied condition, differs from neuralgia in being a much more active inflammation of the nerves or nerve sheaths. In it the nerve is painful to pressure, muscular twitchings occur, and, if the condition continues long enough, a final atrophy and paralysis of the related muscles may result.

Head pain may also be induced by the products of metabolism, which act locally upon the muscles of the scalp and produce pain by irritation of the sensory nerves in the same manner as it is produced in gout and rheumatism. Especially is this liable to happen should the resistance of the muscles have been previously reduced by exposure to cold or drafts. In neuralgias and inflammations there is always a certain amount of associated hyperesthesia, the affected part being, in many cases, exquisitely tender.

In addition to headaches due to local causes are those which are the result of conditions present at a distance from the area in which pain is felt. These are classified as projected, reflex, or referred headaches. Projected headache is the result of pressure upon the cranial nerves, either in their extracranial or intracranial course. Such pressure may be due to tumors, caries of bone (especially caries or periostitis of the bone at the foramina of exit) and to foreign bodies.

Reflex headache is due to a stimulus carried through the nervous system from some distant organ. In these headaches the action is upon the nerve centers, or nerves, either indirectly through adjacent nerve centers, or directly by the action of irritating bodies (toxins of disease and organic or inorganic poisons). The fifth nerve seems to be especially subject to irritation from extraneous causes, and the part that seems to be most commonly affected is the Gasserian ganglion.

Referred headache is the result of a reference of stimuli along associated or related nerve pathways, as is exemplified in the frontal headache following immediately after the drinking of ice-water, etc.

HEAD PAINS OF INTRACRANIAL ORIGIN.—The intracranial causes of headache are: Meningeal changes, functional and organic; cerebral toxemia; cerebral anemia; cerebral congestion; increase of cerebrospinal fluid.

Meninges as a Cause of Headache.—Stretching and pressure exerted on the meninges is the most important cause of headache,[1] and produces the most severe and persistent pain, as in cerebral tumor; here, owing to the general increase of pressure from the growth, the headache is apt to be diffuse. However, when the cortex membranes are involved, the pain becomes localized; and this localization is of the utmost value in defining the site of the tumor.

The general cause of meningeal stretching and traction is pressure from underlying structures. The piaarachnoid is probably not supplied with sensory nerves, and it is very likely that its only nerve supply consists of those supplying the blood vessels. Therefore, in cases of leptomeningitis, it is the congestion incidental to the inflammation that causes pressure upon the dura and its nerve filaments, and so produces pain.

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[1] The meninges seem to be almost insensitive to the ordinary stimuli, as when the skull is opened under local anesthesia they may be touched, pinched or cut, without the patient complaining much of pain.

Stretching and pressure on the meninges may also be caused by an increase in the cubical contents of the cranial cavity, such as occurs by an increase in the brain substance from new growths, abscesses, and increase in the fluids of the brain (blood and cerebrospinal fluid).

Increase in brain substance is found in new growths, such as tumors of the brain. These cause pain by increasing the intracranial pressure. This they do in two ways: (a) by an increase in the intracranial contents, which, owing to the pressure of their mass, cause an increase in the intraventricular pressure, and (b) by raising the intraventricular pressure, either by shutting off the means of exit of the intraventricular fluid by blocking the foramina of communication between the ventricles and the subarachnoid spaces, or else, by pressure on the veins of Galen. A loose fibroma in the lateral ventricle may also act as a plug and thus prevent the escape of cerebrospinal fluid, and cause intolerable headache, optic neuritis, coma and death.

Pain, in some cases, in which the tumor is cortical or subcortical, is produced by the growth pressing directly upon the meninges, and in this way squeezing the terminal nerve filaments incorporated in its substance. Tumors of the posterior fossa of the cranium probably cause the most pain.

Diagnostic symptoms of tumors of the brain are pain, which, in cerebral tumor, owing to the general increase of blood pressure from the growth, is as a rule diffused. When the cortex membranes are involved, the pain becomes localized, and this localization is of the utmost value in defining the site of the lesion. When the pain becomes circumscribed, it is most often confined to the forehead or to the occipital region. Accompanying the pain there are disturbance of sensation and motion, choked disc, rigidity of the pupils, vomiting of a projectile character (with an entire absence of gastric symptoms) and dizziness. Sometimes symptoms of headache may be almost entirely absent in brain tumor, as in a case reported by Edinger, in which, on autopsy, a tumor was found in the Island of Reil of a patient, who had had headache only a short time before death.

Brain tumors may be syphilitic, tuberculous, hydatid, carcinomatous, sarcomatous, or osseous formations within the cranial vault.

Brain abscess causes headache in the same manner as do tumors.

Organic Meningeal Changes. Organic meningeal changes due to adhesions, inflammations and hemorrhages cause headaches. Adhesions between the dura and the cranium are often the cause of severe pain, localized over the affected area. Localized head pain may also be caused by syphilis and trauma, or it may be the result of inflammation. The inflammations causing these headaches are of two types:

(1) Pachymeningitis interna, which is very common in old people, and quite frequently accompanied with small and minute hemorrhages. The headache frequently is introduced by vomiting, which sometimes occurs in paroxysms, with brief intervals. Occasionally it is combined with a disturbance of consciousness or of paralysis of some cranial nerve (see page 180). (2) Acute meningitis gives rise to an increased blood pressure, which, in turn, causes an outpouring of serous fluid into the meninges. This produces pressure on this membrane and on the terminal sensory nerve filaments. It may also cause headache by involving the nerve filaments and meningeal endings in the inflammatory process.

Toxemic Headaches. These are due to: (1) Exogenous poisons, as alcohol, lead, iron ether, nitroglycerin, amyl nitrite, or arsenic, and (2) endogenous poisons, as the toxins of pneumonia, typhoid fever, influenza, small-pox, chronic gastritis, chronic Bright's disease, diabetes, cirrhosis of the liver, cerebral syphilis, gout, hyperthyroidism, starvation, and possibly diseases due to alimentary disturbances. Toxins act by altering the intracerebral pressure through their action on the vasomotors and possibly also directly upon the sensory filaments in the meninges. In addition to the reflex head pain, some slight sluggishness of intellect is generally associated with these conditions, and this may progress to delirium.

Of the toxemias the starvation products due to nutritional defects, caused by anemia, are the most frequent cause of head pain. The head pain which they produce is mostly of local origin and has been ascribed to a lack of nutrition of the trigeminal nerves, or, according to Neuman, to a disturbance of the brain cortex. This disturbance leads to pain. This manner of pain production explains why the headache is relieved when the patient reclines, for, in doing so, he increases the blood supply to the brain and incidentally the nutrition.

Anemia. The diagnostic criteria associated with anemic headaches, which, in a way, are starvation headaches, are pain, generally vertical, and made easier on the patient reclining; pallor, especially marked on the lips; disturbed sleep; drowsiness; edema of the ankles, drooping of the eyelids; and feeble carotid pulsation, a symptom which is of great diagnostic importance. Lenhartz (Munich Med. Woch., 1876, Nos. 8 9) showed that the headache and dizziness of chlorosis are associated with an increase in the subarachnoid pressure; therefore, it is this increase in pressure and (in many cases) not the anemia which is the cause of the headache.

Congestion. Cerebral congestion seems to be a true cause of headache. Edinger claims that the headache of migraine is of this type, i. e., that it is due to a vasomotor congestion. For the explanation of the causes of these headaches, see under Vasomotor, Paralytic Headache, which is described under Headache of Chronic Origin.

Cerebral congestion leads to *an increase in the amount of fluid in the brain.* This increased amount may be the result of an increase in the amount of blood in the brain substance (edema), or in the quantity of the cerebrospinal fluid. The increase in the amount of blood in the brain is the result of an increase in the intracranial blood pressure, or of venous congestion.

Increased arterial pressure in the cranium may or may not be associated with increased (systolic mean) arterial pressure.

In some cases an increased arterial supply to the brain is due both to an increased heart action and to an interruption to the return flow through the venous channels. Some causes of increased intracranial blood pressure, which may, in certain conditions, incite head pain, are the following: stooping, lifting weights, sitting up suddenly, lying down quickly, the horizontal position, hard straining at stool, physical exertion, running and extreme heat.

Predisposing Factors.—There are certain factors which reflexly act upon the blood vessels or the vasomotor centers and cause such a lessening in control that slight causes, which otherwise would have no action, act upon the cerebral centers, and lead to a cerebral congestion. These factors are mental excitement, anger, or mental labor (severe), acting as a reflex cause of neurasthenia, which in turn acts principally as a predisposing factor in headache production. Other reflex and clinical factors are found in alcoholics, coffee and tea drinkers, and in those suffering from fevers. Sunstroke and rapid chilling of the surface, as in colds, also have the same effect. In some cases there is a further lessened resistance to the above acting causes, because of a vasomotor ataxia due to nicotinism (Schmidt). In headache due to increased intracranial arterial pressure the pain generally is of a throbbing nature, the throbbing being due, perhaps, to a backward and forward flow of the cerebrospinal fluid. The pain is accompanied by a fulness of the head especially marked on coughing or on any sudden exertion. A flushed face, injected eye grounds, general irritability, sensory disturbances and increased heart action also accompany this condition. There is also a form of arterial congestion due to a vasomotor paralysis in which pain is present in all parts of the head, but is especially severe on the top and in the temples, where it seems as though the head would burst. There is also a painful sense of pressure behind the eyes, which seem to bulge forward. Periods of freedom from pain intervene; then there are recurrences, often just before the menses, or when the atmosphere is heavy.

In headache due to general hyper *blood-tension,* Matthew (*Quarterly Journal of Medicine,* 1909, II, 261) found that a reduction of about 30 mm. Hg in the blood pressure was almost invariably followed by an alleviation of the head symptoms.

Another cause of hypertension headache is the local increase in blood pressure, the result of inflammation, as in meningitis. Here the pain is generally associated with a slow, strong pulse, though no rise in the mean arterial pressure may be noted. In this it differs from aortic regurgitation, which also causes headache, but in which, although there is a sudden strong pulse (high systolic pressure), the mean arterial pressure is reduced. A third cause, the result of cerebral arteriosclerosis, is the elevation in the cerebral systolic pressure, which may be high, though the mean arterial pressure may be normal.

Moleen writes: "Of the general symptoms of cerebral arteriosclerosis, headache stands first. It is usually dull, not throbbing, and quite often is described as a feeling as though a tight band were compressing the head. It occurs most frequently in the morning after walking about, and diminishes as the day advances, except in syphilitic arteriosclerosis, in which it is usually most severe at night. Dizziness, or vertigo, as a symptom, is next in importance to pain. Numbness, tingling, twitching, weakness in a limb, or in one half of the body, and disturbances in articulation are also common."

Headache may be caused by *increased venous pressure,* as well as by increased arterial pressure; or both may interact to produce increased intracranial pressure. Headaches of the first type are present when there is any obstruction to the return circulation, as in tricuspid regurgitation (which produces back pressure), thyroid enlargement (producing static back pressure), sinus thrombosis, and paroxysms of coughing. Tight neck bands and epilepsy (Knowlton) may also cause headache.

GENERAL CONSIDERATION OF HYPERTENSION HEADACHES.—Hypertension headaches are very severe and usually are badly borne. It is most likely that in all hypertension headaches there is a supersensibility of the nerves supplying the dura, and thus more cognizance than normal is taken of changes in intracranial pressure. In these headaches the pain is eased by the patient drawing his head far backward and burying it in the bed clothes. If the neck-muscles are in a state of tonic contraction, we may presume the lesion causing the condition to be of an inflammatory nature, probably one affecting the meninges. If this is the case, bending the head forward seems to increase the pain, and rotation is also painful, the pain being in the nape of the neck, and frequently on the side opposite to that toward which the rotation has taken place (Schmidt). Swallowing, as well as lying down, at times causes pain. The patient often attempts to fix the head with the hands, so that movement cannot take place. Hypertension headaches are quickly relieved by the taking of a purgative. This would hardly happen if the headache were due to a toxemia, in which case the headache would last for some little time, until the toxic material could be removed. Now, it behooves us to ask, how a purgative so quickly relieves the headache. It is reasoned by Schmidt that intestinal stasis causes meteorism, and that this in turn causes "stasis in the superior vena cava and in the cerebral veins through the restriction of the respiratory venous aspiration"; and purgation causes a revulsion in this condition, and a normal respiratory circulatory activity. He also remarks "that the important part played by normal intestinal peristalsis in facilitating the venous circulation in the portal district must not be forgotten. The headache may be temporarily increased if the act of defecation is accompanied by considerable straining" (Schmidt, p. 13). A point of value in diagnosing increased ventricular pressure is that the pain of increased ventricular pressure is always referred—while that due to meningitis or tumor (meningeal), etc., is always localized to the area involved.

Associated with hypertension headaches are changes in the fundus of the eye, such as dilatation of the veins, hemorrhage into the retina, and choked disc, all of which are due to mechanical agents. There are also present mild inflammatory lesions, partly due to obstruction of the lymphatic return flow.

Pressure points (see Neuralgia, Fig. 44) can often be demonstrated in the area of distribution of occipital-trigeminal nerves. Hiccoughs, vomiting, abnormalities in pulse and respiration, possibly due to vagus involvement, are also found. The spots see dancing before the eyes are due to optic nerve involvement, whil the buzzing in the ears is the result of involvement of the auditory nerve.

Increased intracranial pressure is often evidenced by a visibl distention of the veins of the brow or of the scalp. The degre of stasis may be fairly well judged by the magnitude of the dilatation of the venules of the upper eyelid (Cushing). Where increased intracranial pressure is present, repeated examination o the urine should be made in order to detect, if possible, th presence of a nephritis.

Among other associated symptoms of tension headaches ar great debility, disinclination for any kind of work, anorexia, an distressing dreams with fright on awakening. Actual hallucinations are occasionally present; edema of the cortex of the skul sometimes occurs; red blotches at times cover the entire surfac of the body, and the striæ of the skin, which are produced b stroking with the finger, often persist much longer than the norma time. Thunderstorms aggravate or initiate the pain. Headache of this variety should be diagnosed from those due to brain tumo by an eye examination. Choked disc is present in tension (tumor) headache, and is absent in vasomotor paralytic headache.

Head pain may also be due to an actual, as well as a relative, *increase of the cerebrospinal fluid.* This increase may be localized to either the meninges or the ventricles. Increase in the meningeal fluid without an accompanying inflammation may be due to anemia (such as chlorosis or constipation with acetonemia). Increase in the ventricular fluid may be caused by an increased production of the fluid, or, if the production of the fluid is normal, by a blocking of the foramina of exit (Foramen Magnus or the Acqueduct of Sylvius), which causes an accumulation of fluid in the ventricles. Accumulation of fluid may occur in any of the cavities of the brain, from a blocking of their foramina of exit by new growths, inflammatory exudates, or foreign bodies. That a foreign body may cause such an obstruction is proven by the many reported cases in which the removal of an extraneous substance, such as a bullet from a position in the brain where it was producing obstruction, relieved the pressure and cured the headache. Angioneurotic hydrocephalus is also a cause of head pain which is due to an accumulation of the cerebrospinal fluid in the ventricles. Cerebral compression may also be the cause of an internal hydrocephalus, and thus cause head pain. Cushing, in speaking of cerebral compression the result of tumor growth, says that he succeeded in demonstrating, in the dog, that the longitudinal sinus may completely collapse at an early stage of compression with a venous stasis of high degree. If there is increased tension, from any source, a similar collapse may be produced in the sinus rectus, with stasis in the vena galena, and this produces an internal hydrocephalus without direct implication of these vessels by pressure from a neighboring growth. This internal hydrocephalus produces pressure and traction on the dura mater which results in head pain.

Reflex causes of headache are the last to be considered, but they are not by any means the least important. Reflex headaches are due principally to organic disturbances of the uterus, ovary, eyes (iritis, glaucoma, chronic eye strain), sinus disease (nasal and frontal), hemorrhoids, decayed teeth, digestive disturbances, and toxic disturbances. The reflex headaches are due to irritation of the nerve centers, and owe their presence to circulatory changes in the brain.

Under reflex headaches it is also proper to consider headaches which follow intense irritation of the organs of special sense, for in many cases headaches follow a loud noise, exposure to an intense light, or a strong and disagreeable odor. These headaches are probably reflexes from the centers affected to the centers of the cutaneous area in which the pain is felt.

Hunger headaches are due to a lack of nutrition in the brain cells of the cerebral cortex (in reality toxic headaches). This condition is common in children.

Headaches which follow excessive venery are probably due to cerebral fatigue. To the same class belongs the headache which follows loss of sleep, such as occurs in those who have been up all night, or in those who have missed an accustomed midday nap.

Disturbance of the brain substance from worry, etc., may cause some change in the molecular structure of the cortex, and this, in turn, produces reflex circulatory disturbances, which may be the cause of pain. Associated symptoms of such a state, according to Drein, are malaise, irritability, digestive and visceral disturbances, nausea, confusion of ideas, and vertigo.

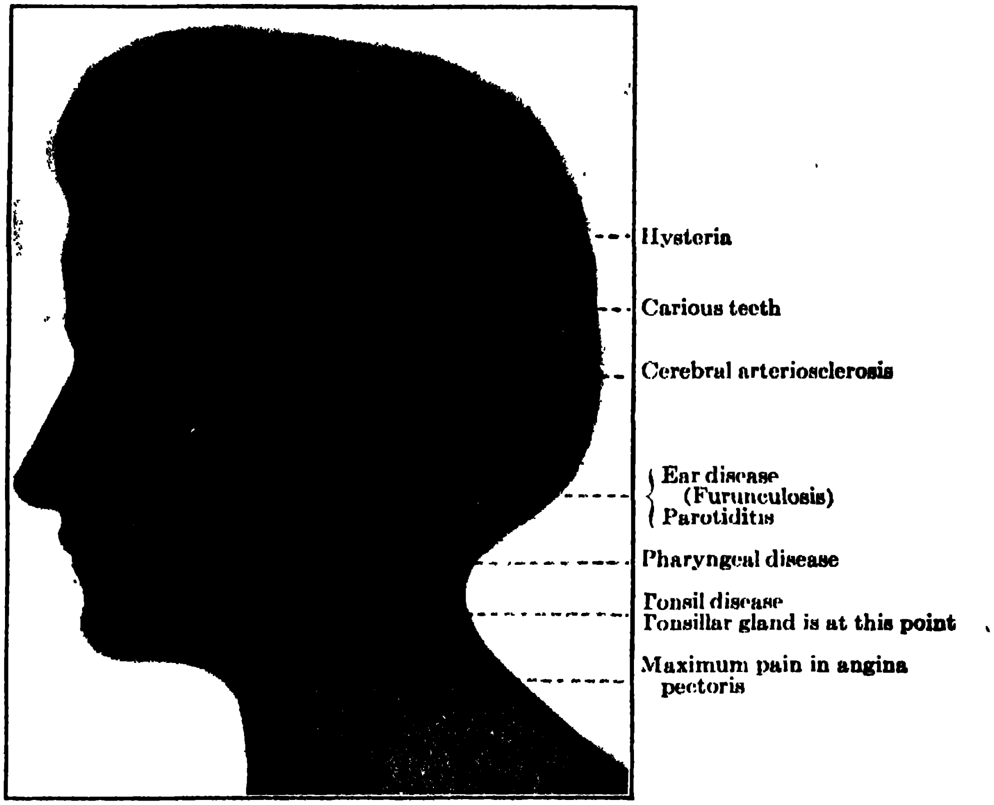
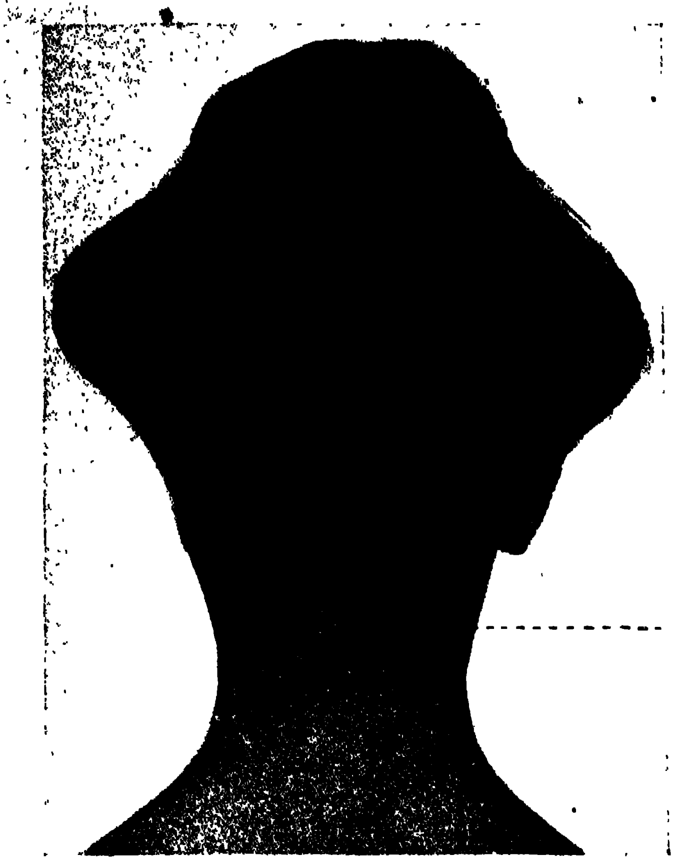

Hysteria
Carious teeth
Cerebral arteriosclerosis
Ear disease (Furunculosis)
Parotiditis
Pharyngeal disease
Tonsil disease
Tonsillar gland is at this point
Maximum pain in angina pectoris

FIG. 64.—LOCATIONS OF THE PRINCIPAL HEADACHES.

Neuralgia of the cortex is also given as a cause of headache. As neuralgia means but an increased irritability of the sensory centers, or of the nerves conducting sensation and is used more to define a functional lesion, it may not be entirely proper to apply the term to the condition in which pain is produced by a cortical organic irritative lesion leading to lessened resistance and increased susceptibility. We find an increased susceptibility of this kind in neurasthenia and allied depressive states, in which a bright light, a thunderstorm, etc., will produce headache. It is also held that there is a headache caused by an irritation of the cerebral cortex by toxic materials, such as was claimed by the older writers (Boerhaave, Van Sweten) to occur



Referred pain from **vertebra**
in { Caries
Tumors
Arthritis deformans }
Meninges—meningitis
Malignant disease (sarcoma) of vertebra
Aneurysm of vertebral artery
Elevation of the intracranial pressure, as in:
(1) Hydrocephalus
(2) Nephritis

FIG. 65.—FIGURE ILLUSTRATING THE LOCATIONS OF THE PRINCIPAL HEADACHES.

The back of the head and the nape of the neck are supplied by: 1. Occipitalis major, which lies toward the mid-line and which is a branch of the 2d cervical nerve which passes through between the axis and atlas, and may be easily injured, owing to the great mobility of these parts; it is also affected in tuberculosis of this region; therefore pain would be felt in the occipitalis major area of distribution in disease of either the atlas or axis. 2. Occipitalis minor, which lies more laterally. 3. Auricularis magnus, which supplies the posterior surface of the ear. Occipital headache pain begins at the junction of the skull and the cranium and runs up the back of the head to the vortex or laterally to the back of the ears.

in rheumatic headaches. These headaches are of a mobile character, and occur at various parts of the cranium, being especially common in the occipital and frontal regions. The pain seems to be well within the skull, and pressure on the surface does not modify its character as is the case in rheumatism of the scalp.

The muscles of the neck are more or less rigid, and the movement of the head is painful. Conditions of cold and dampness influence the head symptoms the same as they influence rheumatic affections of the joints.

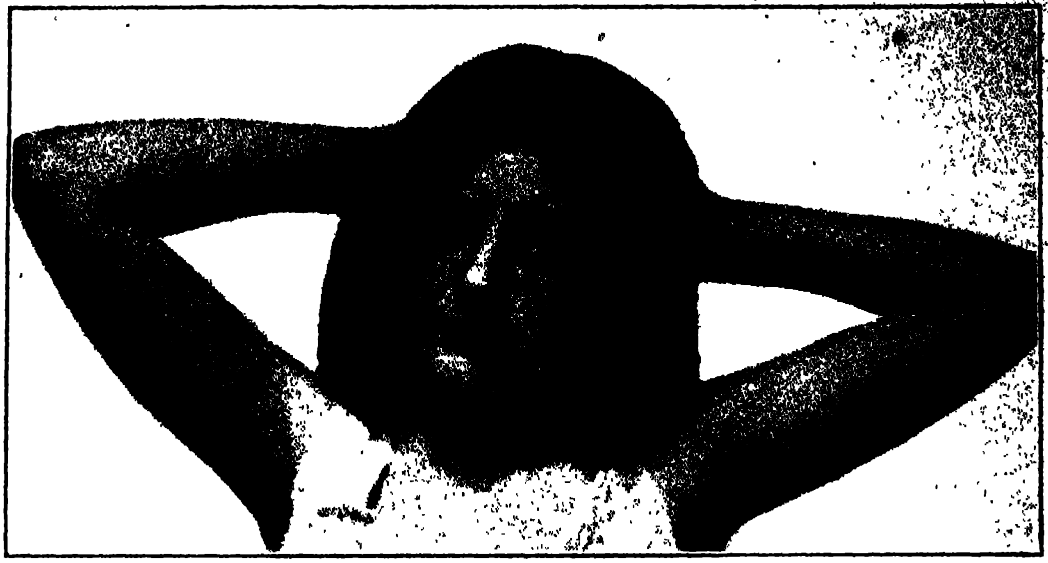


FIG. 66.—OCCIPITAL HEADACHE.

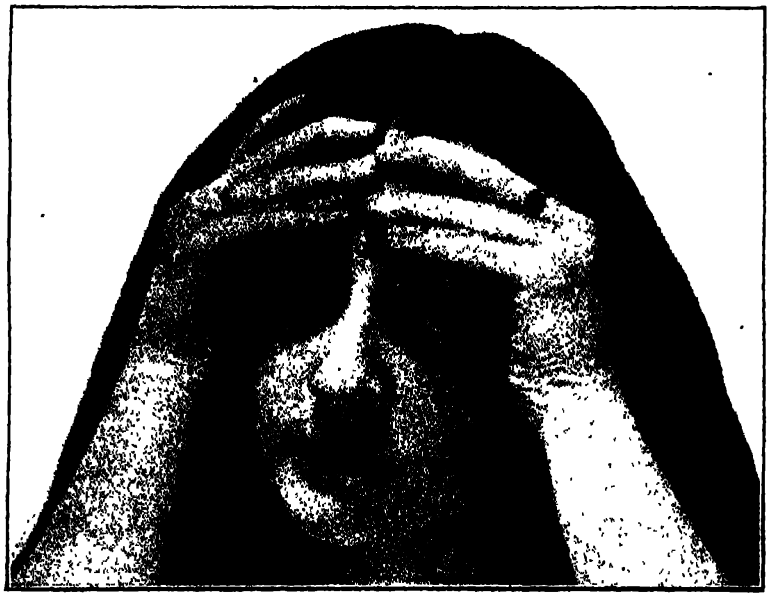


FIG. 67.—FRONTOTEMPORAL HEADACHE.

In many painful lesions of the brain the skin over a certain area of the head is very sensitive to pressure. This is thought to be due to the relations existing between the nerve filaments of the meninges and those of the scalp overlying the affected area.

Diseases producing reflex headaches are: brain abscess, chronic appendicitis, gall stones, chronic gastritis, intestinal derangements, etc. The menstrual period also is often ushered in with a severe headache.

In the accompanying drawings the locations of the principal headaches are given; and since these locations can be illustrated much better than described, the latter has been thought unnecessary. (Figs. 61, 62, 63, 64, 65.)

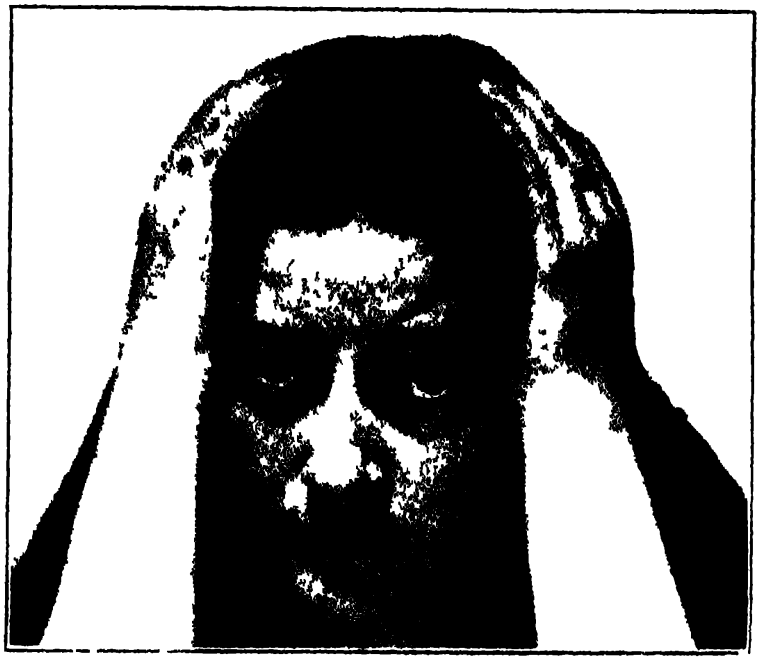


FIG. 68. TEMPORAL HEADACHE

In almost every case of headache the patient tries to ease the pain by making pressure on the head. This is illustrated in figures 66, 67, 68.

Diagnosis of Headache. The following may be of use in the diagnosis of headaches:

ORIGIN. – First, ascertain if the headache is of recent or of remote origin. If it is of *recent origin*, examine for:

(1) Acute infectious diseases in which the pain may be the result of a direct action on the pain-conducting trigeminal tract,

or due to an elevation of the intracranial pressure. The most common infectious diseases causing head pain are influenza, typhoid fever, tonsillitis, and the acute exanthemata (measles and scarlet fever).

(2) Injury (traumatism).

(3) Toxemia: (a) endogenous (hepatic torpor); (b) exogenous (constipation, drugs).

(4) Intracranial lesions (meningitis), either tuberculous or septic. In either case, the characteristics are a constant pain, interrupted by paroxysms of greater severity, and increased by movement or on the taking of food or drink. Vomiting and nausea occur in the absence of the ingestion of food In some cases, when the intracranial pressure becomes high, optic neuritis follows. Tuberculous meningeal headaches, as a rule, are frontal or occipital (Taylor, 632).

Probably the headaches of all the acute diseases are due to toxic causes While headache is a common accompaniment of all acute infectious diseases, yet some, as pneumonia, may be entirely free of headache throughout their whole course.

Remote Origin.— If the headache has been of a chronic type, a knowledge of the relative frequency of the different forms of chronic headache may aid greatly in forming a diagnosis. According to Edinger, two fifths of the chronic headaches are of the indurative type, two fifths are of the migraine type, and one fifth consist of other types. The majority of all headaches are in the frontal region. In our examination of structural changes, as a cause for chronic headache, we begin an examination of the different organs in the following order:

(1) The *eyes* produce the so-called ocular headaches. In these headaches the pain is, as a rule, more severe on using the eyes. Brooks thinks that the principal eye conditions giving rise to headaches are errors of refraction, by which an excessive amount of work is thrown upon the ciliary muscles; want of balance between the external muscles of the globe; and retinal hyperesthesia, in which the retina is very sensitive to light. Ocular headaches are usually located over the middle of the eye-

brow and the pain radiates into the back of the eye (Jessop, 364).

(2) The *nose*[1] causes a pain that lies to the inner side of, and extends higher on the forehead than the pain due to eye strain. The nasal conditions causing headache are stenosis (chronic obstruction due to foreign bodies, rhinoliths, tumors, hypertrophy of the turbinate, bending of the septum), vasomotor alterations, epistaxis, sinus involvement. Iodid coryza should also be thought of, especially in those who are undergoing treatment for syphilis. The cause of the headaches in cases of nasal obstruction seems partly at least to be due to the lack of oxygen, because it has frequently been found that patients suffering from recurring headaches, or from neurasthenia, are immediately relieved of the trouble by the removal of some obstruction in the nose or sinuses. Turbinate headache is usually periodic, depending on the intermittent swelling of the mucous membrane covering the surface of the anterior end of the turbinate. Sinus involvement may cause severe pain; for in one of Hartman's cases trigeminal neuralgia, due to this condition, had persisted for weeks, the pain being so intense that sleep had been impossible. The most diverse treatment had given no relief. All pain vanished immediately after the maxillary sinus was evacuated of the cheesy matter with which it had been filled. In other cases supraorbital neuralgia, which recurred every day at a certain hour, was the result of inflammation in the frontal sinus, and was cured by appropriate treatment. The pain may be due to the inflammation itself, to compression from secretions, or merely to rarefaction of the air in the sinus. The trouble may not be due to an inflammatory process, but merely to the occlusion of the sinus, by which communication with the air is shut off. This is a comparatively frequent occurrence, and is liable to cause distressing pain. Opening a communication into the nose banishes the pain at once (Hartman). A particular variety, met most frequently by Thompson (488), and associated with old fractures of the nasal bones, seemed to begin at the roof of the nose and to pass

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[1] See page 342, Nasal Stenosis.

horizontally backward to the occiput. It was always aggravated by prolonged bending forward of the head, as in writing, and had a special tendency to cause incapacity for mental work.

(3) Diseases in the accessory nasal sinuses are also causes for headaches. The sinuses affected are the frontal, antral, ethmoidal and sphenoidal. Headache due to disease of these sinuses is generally relieved by the discharge of pus or mucus from the nose. In these conditions, the seat of pain is generally frontal, although most authors believe that it bears no special relation to the site of the disease. Lack (623), however, holds that the headache due to sphenoidal sinus involvement is "referred to the back of the head and then radiates down the back of the neck." That due to the ethmoid is found in the frontal region, in the eyes, and deep in the head behind the eyes; while that due to the antrum is found over the molar bone and may extend upward to the temporal region. He also states that the frontal sinus headache is most severe at the "top of the head over the posterior part of the frontal bone" The original location of the pain is generally continued throughout the disease.

(4) The ears, in many cases, cause head pain. The principal causes acting upon the ears to produce head pain are anemia and mastoid disease.

(5) The alimentary tract gives rise to headache. Various forms of mouth disease, gastrointestinal disorders, intestinal parasites, constipation, dyspepsia, and cholelithiasis may be the cause of severe pain in the head. Dull, generalized headache and coated tongue are due to indigestion.

(6) In kidney lesions the pain is felt particularly at the back of the head, and radiates down the neck. Torticollis and disease of the vertebræ should be eliminated.

(7) Brain tumors and abscesses are common causes of headache. The location of the pain often corresponds with the site of the tumor. Sometimes the pain is increased by pressure. It may not be constant, but generally it is periodic. Cerebellar tumors commonly are on the side opposite to that in which the headache is found. Tumor headaches are caused by the pressure

of the growth obstructing the vena magna galeni or the aqueduct of Sylvius (Schmidt), both conditions lead to increased intraventricular pressure. The location of a brain tumor cannot be diagnosed from the situation of the headache. For a fuller consideration of these headaches, see page 182.

(8) Psychical strain will produce severe headache. This is likely to be frontal, and generally is the result of long-continued worry or severe mental effort. A headache of this character is influenced most by psychic states. Mental effort greatly increases it. In this it differs from a headache due to increased intracranial pressure, which is most influenced by mechanical factors, such as change in position of the head and body, bleeding from the nose, or blood-letting.

(9) Between lead poisoning and gout, and the uric acid diathesis, probably there is a close relationship. All these produce headache.

(10) The headache of anemia is due to a hydremic hydrocephalus, with a consequent rise in the intracranial blood pressure. Elevating the head often causes great relief.

(11) Cerebral arteritis: Of the general symptoms of cerebral arteriosclerosis, headache stands first. It is usually dull, not throbbing, and quite often is described as a feeling as though a tight band were compressing the head. It occurs most frequently in the morning, after walking about, and diminishes as the day advances, except in syphilis, in which it is usually most severe at night. A peculiarity worth noting in this class of patients is that, even though arteriosclerosis is present, there is also a lowered blood pressure, which is probably the result of secondary cardiac weakness. It averages from 110 to 130 mm. Hg. The causation of the headache can be explained from the fact that, since the cerebral arteries are terminal arteries, a sclerosis of the coats would cause a narrowing of the lumen, which would produce an anemia of the cortex of the brain. The anemia, of course, would then produce headache and giddiness. Why there should be a systemic lowered blood pressure, is difficult to explain.

The patient should also be questioned in regard to the constancy of the headache; that is, whether it is intermittent or persistent, and then, if it is intermittent, whether the intermittence is regular (periodic) or irregular.

INTERMITTENT HEADACHES (*Periodic Type*).—According to Edinger, two-fifths of all headaches from which patients suffer are of the periodic type. The most important, as well as the best known, of the periodic headaches is *migraine*. Two types of migraine are recognized:

(1) The reflex migraine, which begins later in life than does the true variety, and is dependent principally upon a non-inherited, peripheral cause. In this class of cases there is no evidence of a neurosis in the family, and the headache becomes worse instead of better in middle life. A preliminary visual spectrum is absent. The headaches are warded off by purgatives and laxatives, while, in contrast, the true migraine headaches are not influenced by such means, but are lessened by phenacetin. The principal causes of reflex migraine are eye strain, constipation, and intestinal toxemia. These headaches may also be produced by peripheral factors, as injury to the nerve following a blow on the head, or a fall, in which the third nerve has been damaged. In some cases, after recovery from a head injury, a patch of meningeal thickening may remain and cause head pain. In this form there is sometimes a recurrent third nerve paralysis, and the patient is attacked by severe headache lasting a day or two. The third nerve recovers its functions in the course of some weeks. A visual spectrum rarely develops.

(2) In the hereditary form of migraine there is a distinct history of the heredity. Generally some member of the family has been a sufferer from this condition. If none has been affected with headaches often there is one member who is subject to attacks of epilepsy, neuralgia, etc. Migraine appears in adult life and may be caused by prolonged debilitating diseases. An individual attack is frequently induced by the menses, which it may precede or follow, a prolonged railway journey, a close, badly ventilated room, great heat, emotion (as anger), excitement, the use of a small quantity of alcohol or tobacco, unusually early awakening,

omission of a meal, or strain of the eyes, especially if the strain is on the ciliary muscles.

Migraine gives rise to a throbbing *pain.* It begins with discomfort and gradually increases until it is agonizing in its severity. It generally begins over one eye and then spreads to the forehead and the side of the head. It is increased by bending over, by noises, or by any sudden exertion. Eating may also increase it. Drinking alcoholic beverages and smoking make it worse. Strong light augments the distress. Because of all these, the patient generally seeks a quiet and dark room and lies very still.

A symptom almost pathognomonic of migraine is scintillating scotoma, which appears before the pain commences. The scotomata appear as floating dark spots in the visual field, the borders of which are often serrated and illuminated. Some see only the illuminated edges of the spots, and may complain of dulness of vision.

The individual paroxysm of pain may last for a few minutes, or an hour, while the period of attack may last for a few hours or all day. The premonitory symptoms of migrane are lassitude, irritability and incapacity for arduous work. They often appear in the evening before the attack, while on the morning of the attack the patient complains of numbness in the head and an extremely tired feeling. The pain begins gradually, and is felt deep in the head, with a sensation as though the head were splitting. There are also a burning and a sense of pressure in and behind the eyes. The pain, as a rule, is unilateral. It is associated with a feeling of distress. Loss of appetite and cold feet are often present. The physical signs associated with migraine are: a generally pale face (though it may be red), injected conjunctivæ, narrowed palpebral fissure and contracted pupils. The *contraction of the pupils is an important differential sign,* as in all other conditions where severe pain is present the pupils are dilated. Vomiting, as a rule, finally occurs, and when it does the headache ceases.

True migraine is the most important and commonest of the forms of periodic headache. The severe pain in the head seems to be due to an increase of the intracranial pressure. The hemianopsia, the dimness of vision, the numbness in the tongue, cheek or arm, and the temporary aphasia are all suggestive of sudden arterial constriction in the cortex.[1] Vomiting is also a most characteristic sign of elevation of intracranial pressure.

Brunton is also in accord with the arterial constrictive hypothesis, for he claims that the pain of migraine is due to a contraction of the peripheral part of the temporal artery, and a dilatation of the proximal part. He noticed that in every case of migraine the carotid was widely dilated, while in many cases the peripheral part of the temporal artery seemed to be contracted, and in other cases dilated; but, in every case, the little branch which turns upward on the forehead was found to be firmly contracted. Pressure upon the carotid would oftentimes relieve the pain, which ceased as long as the pressure was maintained, but returned as soon as the pressure was removed. Pressure upon the carotid artery of necessity produces pressure upon the pneumogastric nerve, causing great disturbance to the respiration, with a "feeling as though the entire chest were contracted, or as though someone were pressing down with a giant's weight upon it." Therefore, pressure on the artery, because of these symptoms, cannot be long continued.

These views of Brunton are in accord with the opinions of Edinger and Harris, who also think that migraine is accompanied and conditioned by a contraction of the peripheral arteries. While as yet no vasoconstrictor nerves can be found in the brain, the pale eyegrounds, the general vascular spasm which causes dizziness, and also the occasional disturbances of speech all seem to confirm the anemic hypothesis. Another idea of the cause is expressed by Jelliffe, who follows Spitzner in believing that migraine is due to an absolute or relative stenosis of the foramen of Monroe. According to the same authority, an occasional hyperemia of the brain leads to a hyperemia of the choroid plexus. This, in turn, causes a greater narrowing of the foramen, and an increase of tension in one or both ventricles. This causes a still further congestion of both choroid plexuses, and increases the narrowing. The vicious circle continues until the pressure is relieved or the tension is reduced by a shock reaction, such as occurs in vomiting, or in the use of the vasodilators.

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[1] Although cerebral arterial constriction has been given by many authors as a cause of increased intracranial pressure, it seems to me that the arterial constriction does not cause a congestion but an anemia, and that the primary condition is not an arterial constriction but a dilatation.

According to Levi and Rothschild, there is also a migraine due to a diminished secretion of thyroidin These doctors have succeeded in ameliorating seven cases of migraine with thyroidin; and in their description of thyroid migraine they say that "the existence of this affection is evident by the migraine being relieved with thyroidin; by the hypothyroid signs we meet in people suffering from migraine; by the autotherapy of pregnancy; by the influence of female sexual life (puberty) on the appearance of the affection; by the paroxysmal crises (during menstruation) of the affection; and by their cessation at the menopause. Thyroid migraine symptoms do not differ from those of common migraine. It is either precocious or tardy, hereditary or acquired; unilateral or bilateral; syndromic or symptomatic. It may last only some hours or days, but is always paroxysmic."

Other causes of periodic headaches are, malaria, syphilis, habit, hysteria, lymphatism.

If the periodic headache is due to *malaria*, there is some malarial history. Chills, fevers and sweats occur, an enlarged spleen can be palpated, and plasmodia can be found in the blood.

In headache due to *syphilis*, the pain, as a rule, occurs at night, and is usual after excitement.

Habit Headache.– If a periodic headache occurs at the same time of the day or week, examine for some disease or habit, in the history of the patient, which would be likely to bring on headache, or to act as a predisposing factor in its production. Inquire into the manner of work, sleeping, eating, etc., of the patient.

Hysterical headache may be present, in which case there are other signs of the hysterical involvement.

Ross speaks of a form of headache which he calls the *lymphatic headache*. He describes it as having the following characteristics:

(1) It is present, and most severe, on walking, and tends to lessen in intensity, or altogether disappear, in from one to six hours.

(2) It usually manifests itself as a dull, heavy ache, or as a frontal or temporal throbbing. Less frequently it is occipital, vertical, or unilateral. Infrequently, also, it is neuralgic.

(3) In its typical form it is exceedingly chronic, often of several years' duration, and most intractable. It is the common, occasional headache to which most people are subject.

(4) It is associated with a deficient coagulability of the blood.

The *postures* assumed by patients suffering from the different varieties of headaches are illustrated in Figs. 66, 67 and 68. In all of these headaches, the principal factor sought by the patient seems to be the application of pressure over the painful area. This, in nearly all cases, relieves the pain; so it is possible that in these headaches the pain is a superficial pressure phenomenon (skin, muscles, etc., of scalp), and that pressure applied over the area of local pain removes the congestion and thus relieves the pain.

Hyperalgesic zones of the head, according to Hannsa (62b), frequently occur in lesions at the base of the skull. The most common of these are the result of bullet wounds of the skull, basilar fractures, and concussion. The zones may lie in the area of distribution of the second to fifth cervical segments—or in the distribution area of the trigeminus. Hannsa, as well as Wilms, Milner, Vorschutz, Clairmont, etc., claim that the cause of these zones is a lesion of the sympathetic.

In this connection, also, Head has observed that most of the viscera cause pain which is referred both to an area in the body and, in many cases, also, to one in the head, where it is expressed as tenderness. Head found that these areas were associated with certain visceral areas of tenderness. These associations are given by Head in the table on page 295 (Head, Brain, 1894, p. 464).

1

Frontotemporal
  a. Reference pain from thoracic viscera
  b. Iritis
  c. Glaucoma

2

Frontonasal
  a Substance of the cornea
  b Anterior chamber of the eye
  c. Upper part of nose
  d Incisor teeth of upper jaw

3

Maxillary
  a Glaucoma
  b. Disease of certain teeth of upper jaw

4

Mental
  a Disease of anterior part of tongue
  b Disease of canine and incisor teeth of lower jaw

5

Inferior laryngeal
  Disease of larynx especially the vocal cords and parts below them—feeling as though something is in the throat

6

Sternonuchal
  Disease of the organs of thorax or abdomen

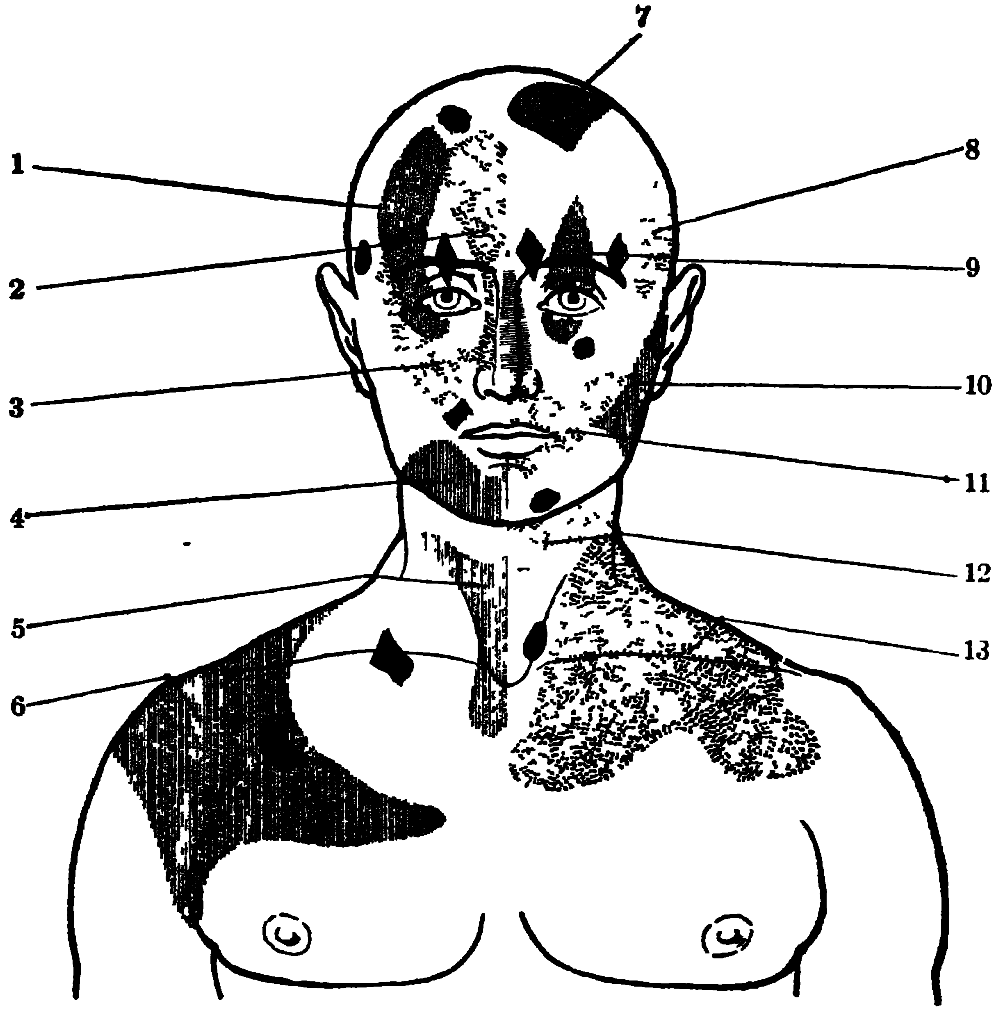

Fig. 69 —Frontal View of Head's Zones.

7

Midorbital
  Hypermetropia

8

Temporal
  a Glaucoma
  b Caries of upper teeth
  c Gastric disturbances

9

Midorbital
  Hypermetropia

10

Mandibular
  Diseases of last two molars of upper jaw

11

Nasolabial
  a Disease of respiratory part of nose
  b Caries of teeth

12

Superior laryngeal
  a Disease of wisdom teeth of lower jaw
  b Disease of posterior part of dorsum of tongue

13

Sternomastoid
  Disease of chest, as tuberculosis of the lung, etc.

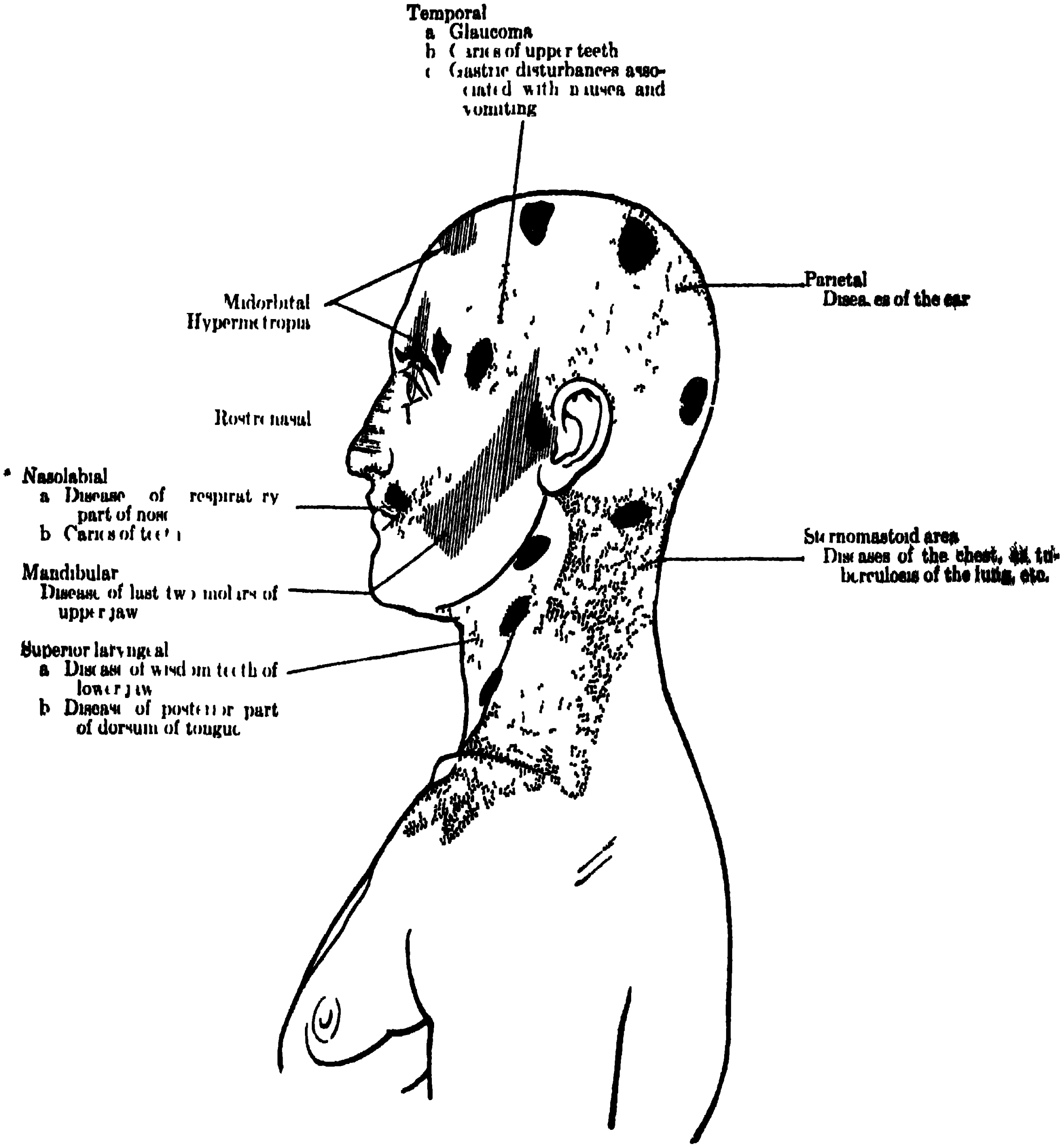
Temporal
a Glaucoma
b Caries of upper teeth
c Gastric disturbances associated with nausea and vomiting
Midorbital
Hypermetropia
Rostronasal
* Nasolabial
a Disease of respiratory part of nose
b Caries of teeth
Mandibular
Disease of last two molars of upper jaw
Superior laryngeal
a Disease of wisdom teeth of lower jaw
b Disease of posterior part of dorsum of tongue
Parietal
Diseases of the ear
Sternomastoid area
Diseases of the chest, as tuberculosis of the lung, etc.

FIG. 70 — LATERAL VIEW OF HEAD'S ZONES
Solid black areas show points of maximum tenderness

It seems that "all the thoracic and abdominal viscera, which refer pain into the dorsal areas of the scalp, are supplied by what might be termed the vago-glosso-pharyngeal nerve— this consisting of the vagus and the glosso pharyngeal nerves. These two nerves represent the visceral branches of a set of nerves whose somatic sensory roots are to be found in the sensory portion of the fifth nerve. Therefore, it is possible to understand how the impulses passing up the vagus may be referred to the distribution area of the fifth nerve.

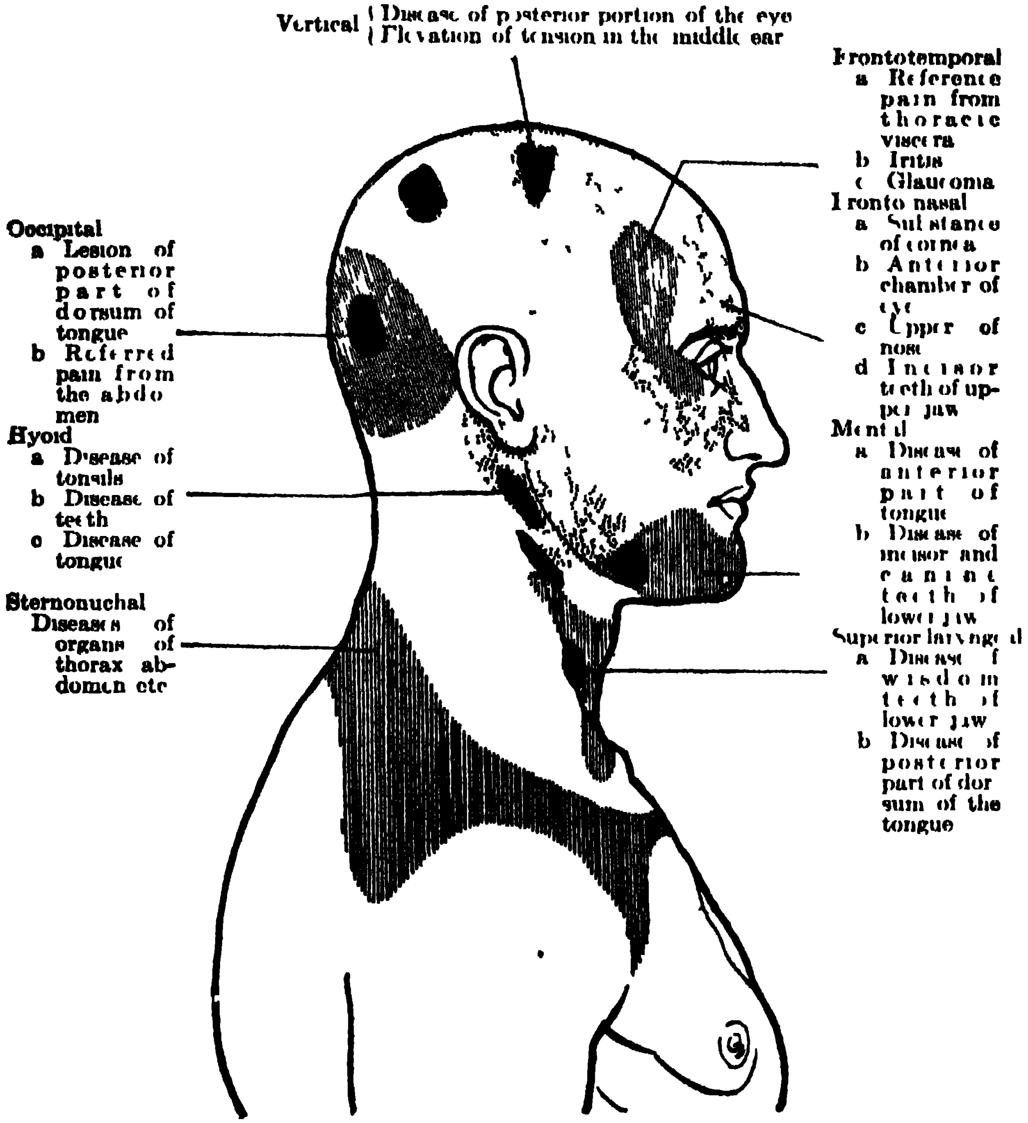
Vertical { Disease of posterior portion of the eye
{ Elevation of tension in the middle ear
Frontotemporal
a Reference pain from thoracic viscera
b Iritis
c Glaucoma
Frontonasal
a Substance of cornea
b Anterior chamber of eye
c Upper of nose
d Incisor teeth of upper jaw
Mental
a Disease of anterior part of tongue
b Disease of incisor and canine teeth of lower jaw
Superior laryngeal
a Disease of wisdom teeth of lower jaw
b Disease of posterior part of dorsum of the tongue
Occipital
a Lesion of posterior part of dorsum of tongue
b Referred pain from the abdomen
Hyoid
a Disease of tonsils
b Disease of teeth
c Disease of tongue
Sternonuchal
Diseases of organs of thorax abdomen etc

FIG. 71 —LATERAL VIEW OF HEAD'S ZONES
(From Head)

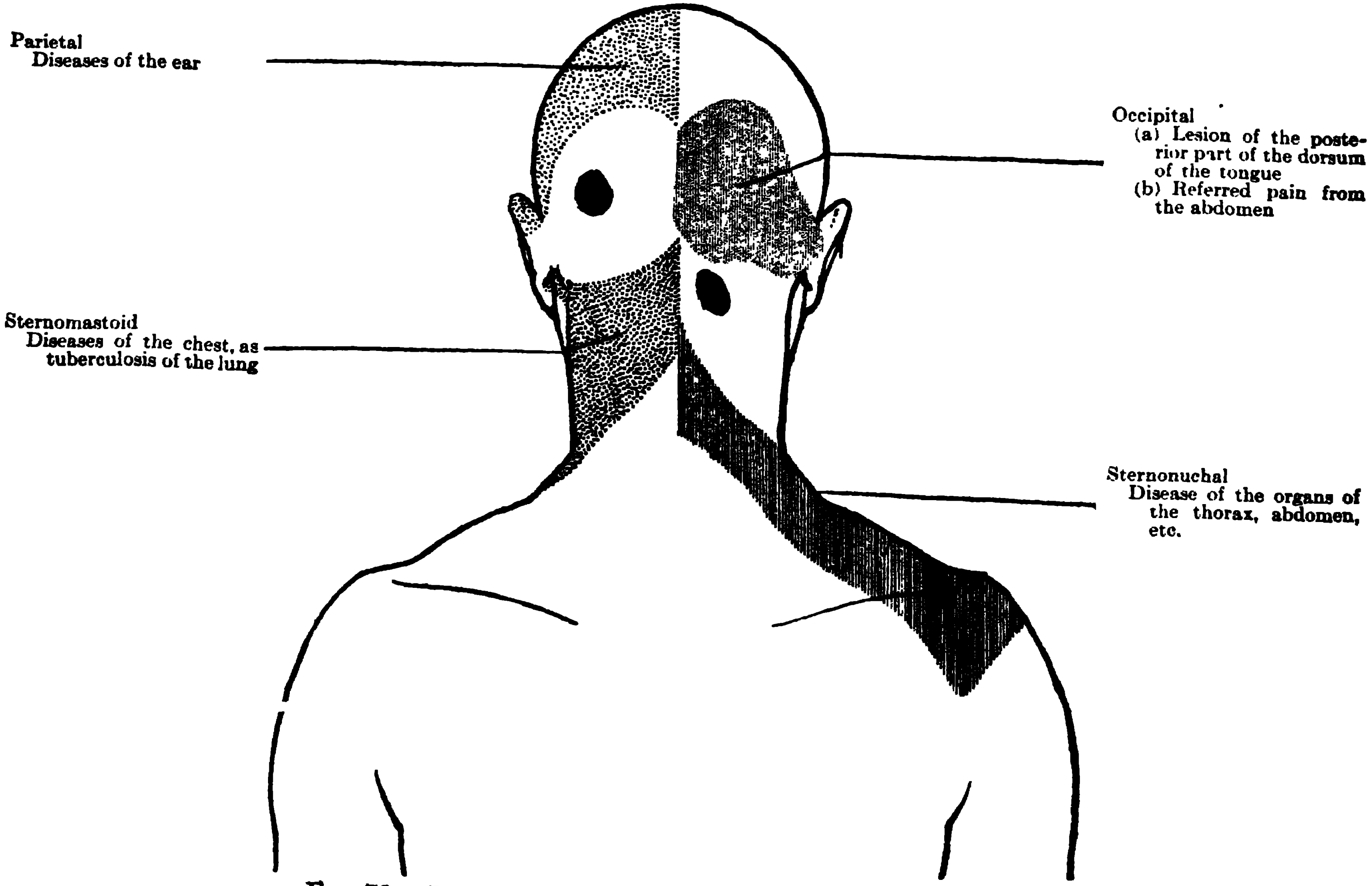
Parietal
Diseases of the ear
Sternomastoid
Diseases of the chest, as tuberculosis of the lung
Occipital
(a) Lesion of the posterior part of the dorsum of the tongue
(b) Referred pain from the abdomen
Sternonuchal
Disease of the organs of the thorax, abdomen, etc.

Fig. 72.—Posterior View of Head's Zones on the Head.

Area on Body	*Associated Area on Scalp*	*Organs in Particular Relation with Those Areas*
Cervical 3.	Frontonasal.	Apices of lung. Liver. Stomach. Aortic orifices.
Cervical 4.	Frontonasal.	Lung.
Dorsal 2.	Midorbital.	Lung. Heart (ventricles). Ascending arch of aorta.
Dorsal 3.	Midorbital.	Lung. Heart (ventricles). Arch of aorta.
Dorsal 4	Doubtful	Lung.
Dorsal 5.	Frontotemporal.	Lung Heart (occasionally).
Dorsal 6.	Frontotemporal.	Lower lobes of lungs. Heart (auricles).
Dorsal 7.	Temporal.	Bases of lungs. Heart (auricles). Stomach (cardiac).
Dorsal 8.	Vertical.	Stomach. Liver. Upper part of small intestine.
Dorsal 9.	Parietal	Stomach (pyloric end). Upper part of small intestine.
Dorsal 10.	Occipital.	Liver Intestine. Ovaries. Testes.
Dorsal 11.	Occipital.	Intestine. Fallopian tubes. Uterus. Bladder (contraction).
Dorsal 12.	Occipital.	Intestine (colon). Uterus.

PAIN IN THE BACK

This includes all pains from the base of the skull to the coccyx. They may be the result of a lesion of the structural units of the back (skin, muscles, nerves, or bone), or may be referred from other regions. The skin of the back is hypersensitive in many of the diseases of the internal organs—in these the zones of Head are, as a rule, pronounced—and in all cases should be sought. In many of the infectious diseases the skin is also very sensitive, both to touch and to pricking.

In examining the back for the presence of pain phenomena first try light touch and pin-point pressure. If these are not painful, make deep pressure, or grasp the muscles between the fingers; should the patient now complain of pain, we may conclude that it is the muscles which are affected. The muscles most frequently affected are in the neck, and the most common affection is rheumatism, which in the neck produces torticollis, and in the small of the back lumbago. These rheumatic affections are characterized by a sudden onset, the great pressure sensibility over definite muscular areas, the increase of the pain on movement, and the favorable influence through massage, faradization and heat. In many cases, also, the pain and tenderness seem to be influenced by the weather, becoming much worse on rainy days. Only by their course do the chronic rheumatisms of the back muscles differentiate themselves from acute forms. Johnson (*Brit. Med. Jour.,* 1881, p. 221) mentions back pains, which lasted a long time, and which appeared on bending forward. They were double-sided, and only unilateral if the vertebræ were held crooked. These pains were worse after their onset, and diminished after a little movement. I have observed a similar case in a colleague. In this instance, however, not the muscular but the tendinous structure was diseased. The colleague complained of back pain, which would appear at certain parts of the vertebral column, upon motion or fixation; for instance, it would appear if he stepped from the pavement incautiously, and upon strong pressure. Examination showed, in this otherwise healthy individual, a high degree of

Sensibility of the vertebral spines of the two lower thoracic vertebræ. Especially sensitive were the connecting fascial ligaments. The overlying skin was also sensitive. Deformity was not present, and sudden pressure over the vertebræ was not especially painful. There was, therefore, no reason to think of a destructive process in the bodies of the vertebræ. I learned that the colleague had worked with a microscope, in a somewhat uncomfortable position, several hours daily for many weeks, the microscope being placed so low that he had to work with his back very much bent. After working with the instrument in a better position, the pain disappeared in a short time without further therapy.

Since lumbago is so frequently confused with that of neurasthenia the following table of diagnostic difference is appended.

	Lumbago	*Neurasthenia*
Pain located.	In the region of the lower lumbar vertebra and spreads out sideward	In the sacral region and spreads upward
Method of onset	Sudden	Very gradual
Influence of motion	Increases pain	No action on the pain
Points of tenderness	Pressure on increases the pain or also produces it	No pressure points
Psychical influence	Mental states have no influence	Is influenced greatly by mental states, irritation (psychical) increases the pain, diversion reduces the pain
Vertebral column	Often some change or deformity present, such as scoliosis this can be differentiated from other forms of scoliosis by having the patient lie on the affected side, in a sharp angle, when the scoliosis disappears.	No change or deformity.

Myalgia, due to *toxemia*, is nicely illustrated in those infectious diseases in which backache is one of the most prominent symptoms. In small-pox the pain in the back is so severe that the patient, in many cases, is in the greatest distress. The nature of this pain, however, does not long remain in doubt, for the presence of the eruption soon clarifies the situation. In the so-called break bone fever, of the Southern States, it is also most severe. Amon the other infectious diseases in which backache is a prominen symptom are relapsing fever, influenza, tonsillitis, typhoid feve and diphtheria.

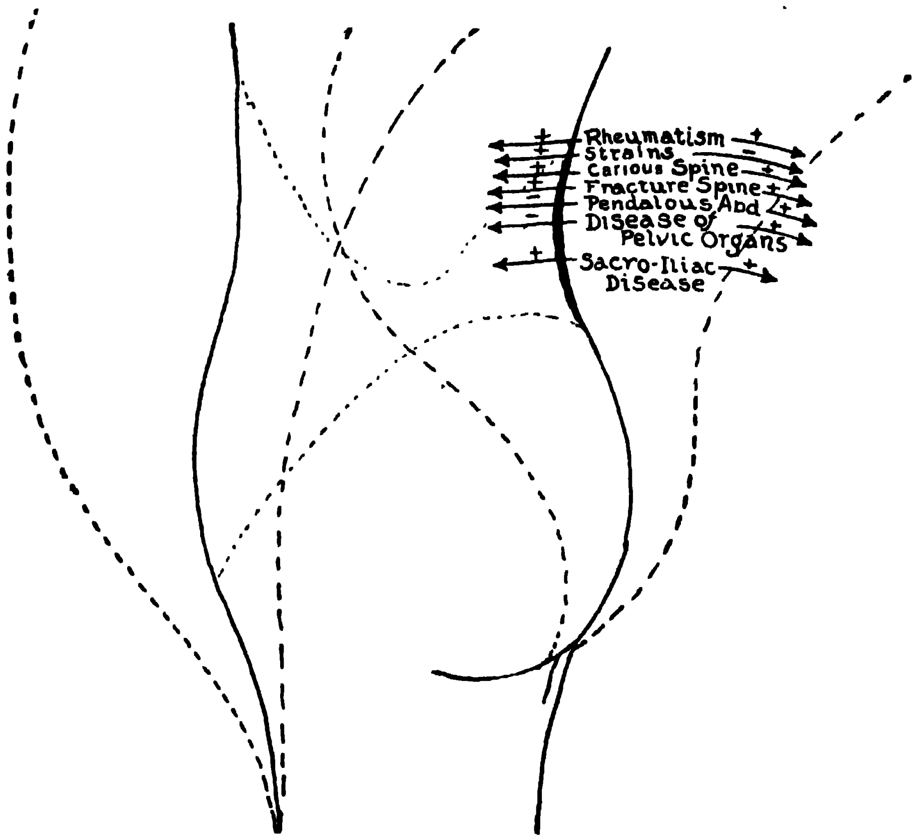

FIG. 73.—FIGURE SHOWING THE MODIFICATIONS OF PAIN IN THE LUMBA REGION BY CHANGE OF POSITION.
The arrows indicate the direction of movement and + indicates increas of pain, while — indicates decrease of pain in the diseases mentione when the motion is made as indicated.

In myalgia from *sprain* some history of injury is usuall obtainable, and in some cases evidences of traumatism are present In myalgia due to *fatigue* the pain is more of an aching character Sitting upright or standing increases the pain. Ease may b obtained, as a rule, by reclining. This condition is frequentl associated with neurasthenia, anemia and depressed mental o physical states. Such a fatigued state is frequently experience by dentists, mechanics, barbers, surgeons, or comes on after certain forms of exercise, such as rowing. Pain may also be due t inflammation in the subcutaneous tissues, as in perinephritic abscess and inflammation of the retroperitoneal glands.

In the neck, the sternomastoid muscle, either as a result of changes in its substance (result of toxic irritations), or as a reflex from other adjacent structures (neck glands, Ludwig's angina, vertebral, or local lesions), or from neurotic influences (either congenital or acquired, acute, or chronic), becomes so sensitive that it remains in a state either of tonic or clonic contractions. When the contractions are chronic they abate gradually but quickly reappear on the least irritation or attempt at movement. This condition is termed torticollis. For a fuller description of this the reader is referred to special works on the subject.

After a consideration of the muscles as causative factors of the back pain the vertebra and joints should next be considered.

Vertebral diseases, as tuberculous caries (when inflammation is acute), cause pain, elicited either by sharp spinal shocks made by forcibly pushing the head downward, or by having the patient stand with feet together and then, after elevating himself on his toes, bring the heels down to the ground with considerable force. When vertebral disease is present, pain will usually be felt in the diseased area. Involvement of the third to the fifth vertebra generally gives rise to more pain on bending forward or backward than does involvement of other vertebræ, because it is at this level that flexion and extension of the spine most frequently occur (Cooper, 807).

Leukemia with vertebral myeloma may also give rise to back pain, likewise, also, the vertebral metastatic growths, especially prostatic, mammary, or adrenal tumors.

The sacrovertebral joints are also a frequent cause of back pain, which may be either the result of inflammation, or of dislocation. If of inflammation the same signs and symptoms of inflammations are found as in other inflamed joints (see page 239).

Dislocations also display here the same signs as when they occur elsewhere. Here, however, should be mentioned the *sacro-iliac* dislocation, the pain of which causes it frequently to be mistaken for lumbago and sciatica. However, in this condition the pain is in the sacroiliac region, and extends down to and over the anus. There is also rigidity of the retrospinal muscles.

For the elucidation of this lesion Goldthwaite (800) has formulated two tests (an anterior and posterior one), which are known by his name. He describes them as follows (*Annals Surg.*, Vol. LI, No. 3, p. 420):

"For the anterior test, place the patient on a bed with, say, the right limb fixed on the bed; then the left leg is lifted from the bed without flexing the knee. If it does not go as high, if the extension or flexion of the limb, when the limb is extended, is not equal to that on the other side, and if the pain is acute, we suspect an anterior displacement of the sacrum. The posterior test can be made by extending the limb upward, with the patient lying on the face." The diagnosis between muscular and ligamentous pain of the spine (Cooper, 802) is that passive *posturing* will cause pain if the ligaments are involved, while if the muscles are involved, active posturing will cause pain.

Reynolds and Lovett (805) also speak of cases in which, owing to an abnormal stooping-forward position, the center of gravity is moved forward, and, as a consequence, considerable strain is thrown upon the ligaments and back muscles, with the consequent production of pain.

Osteomalacia is also productive of very severe back pain, but the associated pregnancy and the typical pelvic and sacral deformity render its diagnosis easy.

Pain over the coccyx (the so-called coccydynia) may be due to injury of the coccyx from a fall, or from over-distention of the inferior pelvic outlet during childbirth. It is also found in hemorrhoids, anal fissure, and proctitis. Lesions of the conus medullaris also may cause pain referred to this region.

Referred pain may be felt in the back and be present, either as a result of disease of the viscera, or of some more distant organ or region. The viscera lesions, most of which commonly give rise to pain in the back, are: the lungs, stomach, intestine, liver, and gall-bladder, kidney, pancreas, spleen, and pelvic organs.

Lungs.--Affections of the lungs, if they extend to the pleura frequently lead to pains which are felt in the back, especially as the patients localize the pains in the upper part, in the intrascapular space and in the shoulder, if the area of disease is localized in the apex or in the upper lobe. The more frequent cause for such a condition may be a beginning tuberculosis. Pressure sensibility of the skin and musculature, in the above-mentioned region, is not often present. Increase of the pain in breathing, and especially in coughing, gives an indication, and an exact examination of the lungs makes the cause clear.

Heart and Aorta.- Just as frequent causes for back pains are affections of the heart or of the aorta. Here the pain occurs not only in the back, but also may be found as radiating pain in the arm, especially in the left arm and in the left shoulder. A frequent complaint of such patients is a sensation of constriction of the thorax, as though it were being pressed in a vise; but in this case the hand of the corresponding part of the back, or the shoulder and the left arm, are oversensitive. It will not be hard to differentiate these varieties of pain from those which are caused by disease of the spinal cord or of the dura. The circumstances that heart pains almost always occur in paroxysms, and that these attacks, in the first place, are called forth through bodily exertion, psychical irritation, etc., indicate their origin in the heart. An exact examination discovers changes in the aorta and the cardiac muscle. Absence of signs of a spinal cord disease completes the finding.

Stomach.- With the referred pains of gastrointestinal visceral disease are associated the hypersensibility of the skin and musculature of the painful region, and of the corresponding part of the vertebral column, on the left side, in particular. But these pains, as they are especially observed in ulcer of the stomach and in pyloric stenosis, are not very difficult to connect with the stomach, since their appearance and variations in intensity depend chiefly upon the taking of nourishment, and especially upon the quality of the food. It is unnecessary to say that the further examination of the stomach, in such a case, must yield signs of disease of that organ. In many cases of total stenosis and cramp of the esophagus, a severe pain is frequently felt in the shoulder region, and a girdle sensation is experienced in the thorax.

Intestines.—Pelvic pains are frequently due to diseased processes in the intestine. Gas collections in the large intestine produce pain in the pelvis and in the flanks, the cause of which reveals itself upon the application of a purgative. Intestinal ulcers do not so frequently cause pelvic pain. On the contrary, pelvic pains in carcinoma are an important diagnostic phenomenon. Very frequently they are associated with a radiation in the limb and in the perineum, especially if the carcinoma is situated in a deeper part of the colon. Yet, here the pains almost never appear without accompanying symptoms. Very frequently they are associated with intestinal symptoms, so that their recognition causes no difficulty. Only an inflated colon can, as a single pathological entity, produce dull pain in the back, usually on a level with the kidneys. But here an exact anamnesis, with the fact that the onset of the pain depends upon the passage of feces or of gas, makes the diagnosis clear.

Liver and Gall-bladder.—One observes, very frequently, in liver and gall-bladder troubles, pains in the shoulder, in the arm, and in the back—almost always on the right side. There is often, also, an excessive sensibility of the skin and of the corresponding musculature. This can be demonstrated upon picking up folds of the skin and pressing upon certain places (the region near the tenth to the twelfth vertebral spine). When the remaining signs of gall bladder and liver disease are found, the diagnosis is complete.

Kidney.—The spontaneous and pressure sensibility in diseases of the kidney (inflammation, embolism, congestion, tuberculosis, neoplasm) is situated in the flanks and pelvic region. Frequently, also, hyperesthesia of the skin is found. Here chemical and microscopical examination of the urine make an important differentiation. In connection with pus inflammation (perinephritic abscess) pain occurs in the lumbar region, which is increased by touch and pressure, as well as by coughing, sneezing and motion. In a similar manner, the pain of nephritis manifests itself. Radi ation occurs in the thigh or is present in the form of an intercostal neuralgia. Patients with kidney stones complain of trouble and pressure in the lumbar region. If the pain is intense, and takes the form of colic, it radiates downward, as a rule (thigh, testicle, ovary). Frequently, however, it is found in the lumbar region and in the loins. The direction of this radiation, and the circumstance that the lumbar pain is increased, if one makes a journey over a rough road, would lead one to think of a kidney stone, further signs of which are disclosed upon examination.

Pancreas, Spleen, etc. Of the pains of many *pancreatic* affections, it is likewise known that they radiate in the back, or (in girdle form) towards the front. Frequently diseases of the *female genitalia* lead to severe pelvic pain, and finally the *spleen,* also, under some conditions, produces pain which radiates into the pelvis, the left shoulder, the left shoulder blade, and the interscapular region. Spleen tumors, especially, produce pain, and their presence will be thought of as an associated condition by the presence of the above described pain.

The pelvic organs (uterus and ovary) are probably the most frequent causes of backache in women. The principal lesions are a malsituated uterus (retroversion, retroflexion, or the binding of it down to the pelvic floor by adhesions, in which the pain is worse just before the menstrual period); and inflammation of the uterosacral ligaments (Garrigues, 803). Tender spots on either side of the second sacral vertebra are due (Garrigues) to cellulitis of the uterosacral ligaments. Pressure over the inflamed uterosacral ligaments produces pain at these places. The pain is worse on exertion, especially in sweeping. Sexual intercourse is painful, as a rule. Examination will disclose the abnormal and painful ligaments. *Pregnancy* and *menstruation* are also potent causes for backache; but in these conditions there is generally present some previous disturbance of the lumbar structures which predispose them so that the addition of congestion or traction, resulting from pregnancy or menstruation, produces pain. In some cases, during pregnancy, an actual relaxation of the sacroiliac ligament is present (Andrews and Hoke, 806).

Inflammations of the uterus may also cause backache. (For a fuller consideration, see "Pain in the Female Genitalia," Chapter XXXII.)

The *genitourinary organs* in the male (prostate, seminal vesicles) cause lumbar pain. The urinary bladder, also, when diseased, frequently gives rise to pain in this region.

Back pain may also be caused by static foot errors, hysteria, anemia and chlorosis.

In *static foot errors* the pain is relieved on the patient lying down, or on the correction of the errors of position.

"In *hysteria* the backache is usually referred to the lumbar and sacral regions. It often extends upward over the dorsal area and downward over the gluteal muscles" (Clara F. Dercum, 150).

Anemia and Chlorosis. - The anemic and chlorotic individual very frequently complains of back pain. It occurs as rheumatic pain, which is most severe in the morning, after arising, and improves during the forenoon, if the patient moves about.

The lesions of the spinal cord causing back pain have been previously considered, and will not be dwelt upon here.

PAIN IN THE LIMBS

After the consideration of back pains, it is next in order to discuss the pains which usually are present in the limbs. The *upper limbs* are probably not so frequently subjected to pain sensation as are the lower limbs; and when they are, the causative factor is more likely to be of a circulatory nature. The principal pain areas are in the joints, which are frequently affected by rheumatism. The *shoulder joint,* in particular, is subject to gonococcus infection. Over the shoulder are also found the reflected pains from the liver on the right side, and from the spleen, pancreas and stomach on the left side On both sides pains reflected from the diaphragm, extrauterine pregnancy and pleura are found. In the shoulder also is present the pain resulting from inflammation of the deltoid bursa, which lies between the humerus and the acromion process of the scapula. A characteris tic of this pain is, that it is caused by elevating the shoulder, and is very severe until the arm becomes horizontal, when the pain disappears. The pain is localized immediately below the acromion process, between this process and the head of the humerus. Tenderness is also most marked at this point.

Generalized pains are usually neuralgic in origin (for which the reader is referred to the section under Brachial Neuralgia).

The LOWER EXTREMITIES are greatly affected by circulatory changes. A slight indication of the type the symptoms may assume is given by the so-called sleeping pains which follow upon the partial stopping of the circulation in a limb. Generalized pain of a paroxysmal character, more pronounced on the external and posterior surfaces than on the internal surface of the limb, is likely to be due to a sciatica (a complete description of which is given in a separate section). When the pain is on the anterior surface of the thigh, and runs down and to the inner side, it is probably due to involvement of the anterior crural nerve. Should neuralgia be present the pain is paroxysmal and is of great intensity. If it is a referred pain from pressure on the nerve from tumors or bowel accumulations (William Bruce, 502), it is more of a steady, constant, dull ache.

In the lower limbs, the joints, especially the *hip joints*, are very prone to tuberculous infection. The hip, when so affected, at first causes a pain on the inner side of and somewhat posterior to the knee; so that, in many cases, disease of the knee joint is falsely diagnosed. Rheumatism is also common in these joints, and frequently pain and swelling in the knee follow upon the locking of the joint by a so-called rice body. The pain is due to a stretching of the ligaments. It may be only a pinching pain, or it may be excruciating, if the cartilages are caught (Barker)

Flat-foot, also, is a potent cause of pain in the region of the knee. The pain is on the inner side of the patella and may radiate up and down the front of the leg. The pain is much increased on active exercise of the foot, especially by running or walking. Pain in the legs which is not influenced by position, pressure, heat or cold is often the forerunner of brain hemorrhage. When it occurs in persons of advanced years, with hard arteries, it should be looked upon with suspicion (Musser).

At times the *heel* is very painful (pododynia)—so much so that the patient is unable to walk. This pain may be due to local conditions (exostoses on the surface of the os calcis). Those on the posterior and inferior surfaces are the most frequent (Thorndike, "Orthopedic Surgery," p. 161); there may also exist spurs running out from the under side of the os calcis; bursitis of the bursa under the os calcis; or an associated flat-foot may be present (Keen's "System of Surgery," Vol. II, p. 56). Painful swelling may also be present on the posterior surface of the heel at the insertion of the tendon-achilles into the os calcis. The patient walks with the feet everted, while the use of the calf-muscles is painful. Pain in the heel may also be caused by lesions which are at a distance, as from urethral stricture (Luxmoor, Brodie, Thompson, Van Buren, Keyes, and Gouley), vesicle calculus, cysticoprostatitis, inflammation of the neck of the bladder, cystalgia, or neuralgia of the neck of the bladder, which, in some cases, may be mistaken for bladder stone (Von Pitha, 272), renal calculus, gonorrhea (Fournier, 271), and locomotor ataxia (Seguin and Buzzard). It is also present in pregnancy. Pain on the sole of the foot may be caused by exostoses on the internal cuneiform or the base of the first metatarsal, or at the junction of the scaphoid and cuneiform (Thorndike).

A peculiar and painful affection of the foot, occurring only in adults, and most frequently in women, is termed *metatarsalgia* (Morton's disease).

"Typical cases of this affection have sudden cramp like pains starting in the third or fourth metatarsophalangeal articulation and radiating to the tips of the toes and up the leg. The sudden onset may be brought on by a misstep, or by the fatigue of standing a long time, and occurs almost invariably when the shoes are worn. In some attacks are infrequent; in others they practically disable the patient and are provoked by inappreciable causes. The pain is so great that the patient removes the shoe, rubs and compresses the front of the foot, flexes and extends the toes, and, after a time, the pain ceases, leaving no sign, or only a very slight soreness over the articulation on deep pressure. The cramp-like pain may be referred to a single or to several adjoining joints or to all the bones of the metatarsal articulation. It is due to a pinching of the plantar nerve between the bones, or to an abnormal strain on the ligaments connecting the heads of the metatarsal bones" (Thorndike).

Tenderness is found on pressure over the heads of one or more metatarsal bones, or on lateral pressure in the region of the metatarsophalangeal joint (Forbes, *Montreal Med. Journ.*, April, 1909).

PAINS IN THE ABDOMEN

If a pain is of a peculiar, dragging nature, increased on breathing, and especially when deep inspiration or complete expiration is performed, and if it runs round the chest from the ensiform cartilage in a slightly downward direction to the tenth rib posterior, it is generally the result of diaphragmatic traction. It occurs in great cardiac and respiratory activity, dilatation of the stomach, severe tympany, coughing, sneezing, or hiccoughing. A pain slightly lower, and restricted to the area of the liver, may be caused by hepatitis (see Liver). On the left side, over the area of the spleen, a perisplenitis similarly will cause a pain.

Pain localized immediately in the middle of the abdomen, between the ensiform and the umbilicus, may be due to pancreatitis, ulcer of the stomach, gall-stones, cardiac lesions (tricuspid regurgitation), liver and adrenal diseases, epigastric hernia, and duodenal ulcer. If the pain is located around the umbilicus, the causative lesion may be a hernia of the linea alba, volvulus, embolus of the superior mesenteric artery, meteorism, tympany, intestinal obstruction, swollen mesenteric glands, early stage of appendicitis, ileocolitis and intestinal strangulation.

Pain downward and slightly to the right is very severe in appendicitis, oophoritis and salpingitis. Pain on the left side is severe in salpingitis and oophoritis. On either side pain running from the back around to the anterior surface of the abdomen and

1
Diaphragmatic traction as in great cardiac and respiratory activity
Dilatation of stomach
Coughing, sneezing, hiccoughing

2
Perihepatitis

3
Ovaries and tubes

4
Appendix and Fallopian tubes

5
Broad ligament

6
Femoral hernia
Inguinal and femoral adenitis

7
Pain radiating down to foot
Phlebitis
Crural neuralgia
Disease of femur
Femoral hernia
Abdominal tumors pressing on crural nerve
  Aneurysm
  Uterine or ovarian tumors
  Tuberculous abscess (psoas)

8
Joint
  Rheumatism
  Tuberculosis
  Inflammation
  Stretching of ligaments

9
Erythromelalgia
Neuritis
Premonitory of apoplexy
Disarticulation
Articular cartilages

10
Lithemia
Spurs on os calcis
Bursitis under os calcis
Associated flat foot

11
Gout
Bunion

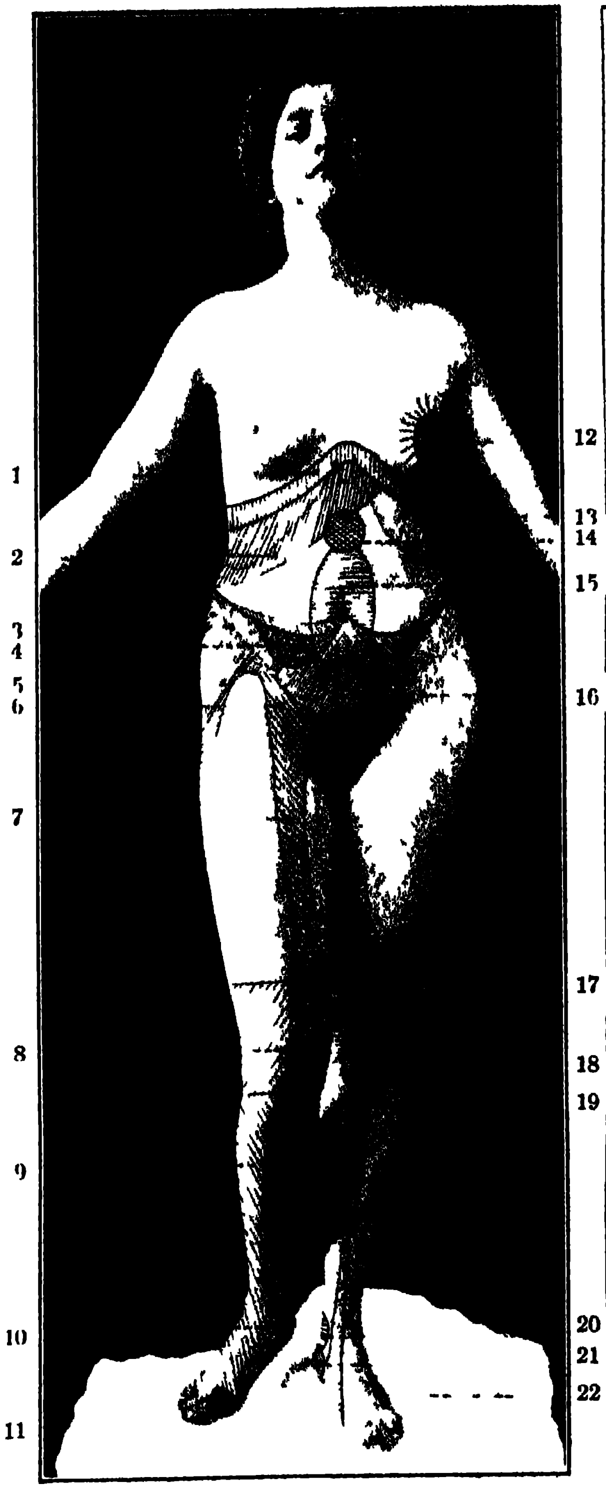

FIG. 74. PAIN AREAS IN TRUNK AND LOWER EXTREMITIES

12
Cancer of breast
Mastitis
Uterine disease

13
Splenic disease
Perisplenitis

14
Pancreatitis
Ulcer of stomach or duodenum
Gall stones
Cardiac lesions (tricuspid regurg.)
Liver involvement

15
Hernia of linea alba
Volvulus
Embolus, sup. mes. artery
Meteorism
Tympany
Intestinal colic
Intestinal obstruction
Intestinal strangulation (hernia)
Swollen mesenteric glands
Peritonitis (generalized)

16
Bladder lesions (cystitis, etc.)
Uterine lesions
Renal and ureteral colic
Lesions of large intestines, colic, etc.
Embolus of inf. mes. artery
Tubo ovarian disease
Pelvic peritonitis
Rupture of abdominal hollow viscous
Extra uterine pregnancy
Pelvic cellulitis (broad ligaments)

17
Referred pain in hip joint disease
Obturator hernia

18
Tender point in flat-foot

19
Pain in flat-foot

20
Postcalcaneal bursitis

21
Disease of ovary
Neurasthenia

22
Morton's disease (metatarsalgia)

1

Pain above the umbilicus
- Lesions of small intestine
  - Strangulation
  - Volvulus
  - Intussusception
- Embolus sup. mes. artery
- Arteriosclerosis sup. ma.
- Pancreas disease
  - Inflammation
  - Cancer
- Liver, gall-bladder or duct disease
- Stomach disease

2

Pain below umbilicus
- Colonic disease
  - Cancer
  - Intussusception
  - Colonic impaction
- Rectal disease
  - Cancer
- Embolus inf. mes. artery

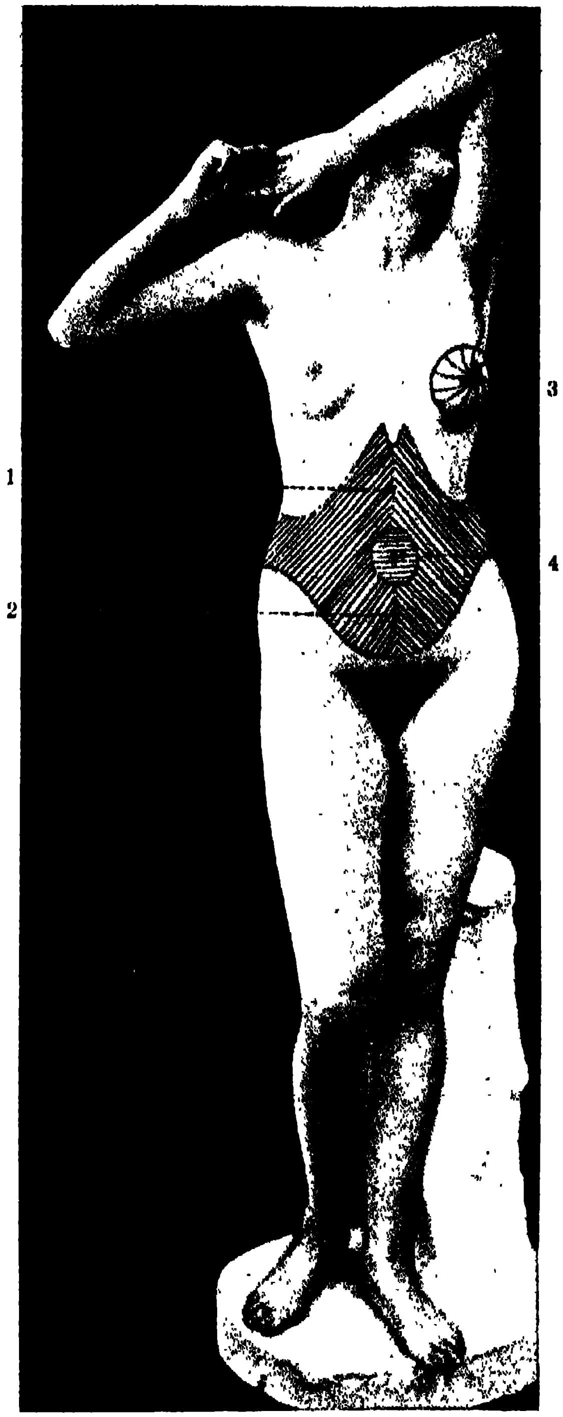

Fig. 75—Pain Areas in Breast and Abdomen.

3

Breast diseases
Uterine disease
Pregnancy
Menstruation

4

Circumumbilical pain
- Appendicitis
- Typhlitis
- Perityphlitis
- Ileum disease

Pain over entire abdomen
- Peritonitis
- Rheumatism or neuralgia of the abdominal wall
- Intestinal perforation
- Tympanites
- Pneumonia (children)
- Aneurysm (abd. aorta)

then down to the testicle or labia generally indicates a renal or ureteral disorder.

Pain below the umbilicus in the mid-line is found in colonic disease, rectal disease, embolus of the inferior mesenteric artery, uterine disease, or disease of the urinary bladder.

Pain over the entire abdomen results from disease of the abdominal wall (myalgia, neuralgia, rheumatism, peritonitis), intestinal perforation, tympanites, enteroptosis, referred pain in pneumonia (in children), and aneurysm. For a more complete discussion of abdominal pain, see Chapter XIX.

Pains due to tabes are very frequent in the abdomen.

CHEST PAIN

Pain over the chest in the sternal region may be caused by diseased bone, mediastinal inflammation, changes in the mediastinal glands, aortic aneurysm, bronchitis and stomach disorders. Over various areas in the chest are the pains from pneumonia and pleurisy. Radiating around the chest wall and paroxysmal in type are the pains of intercostal neuralgia and vertebral and cord diseases. Pain localized to the pectorals and made worse on raising and lowering the arm results from rheumatism of the pectoral muscle. It can also be the result of invasion of the pectorals in cancer of the breast.

Pain on the left side, over the cardiac region, indicates a possible lesion of the heart, and this is confirmed, if it is found that the pain runs down the ulnar side of the arm; even as far as the little finger. Pain in the breast is frequently present during menstruation, in pregnancy, and in uterine and ovarian diseases. It may, also, be the result of a local inflammation, in which case the entire breast is markedly tender and signs of inflammation are present.

CLAVICULAR PAINS

Pain in the clavicular region is frequently associated with new growths (pleura, clavicle), aneurysm of the subclavian, and pulmonary tuberculosis. In the supraclavicular region it may be

1

Mental neuralgia
Toothache
Disease of inf. max.

2

Laryngeal disease
Thyroid disease
Tracheitis

3

Sternomastoid disease (wry-neck)

4

Liver disease
Extrauterine pregnancy (in female)
Suprarenals
Diaphragmatic pleurisy
Colon

5

Disease of bone (sternum)
  Necrosis
  Tuberculosis
  Periostitis
Mediastinal inflammation
Mediastinal glands
  Inflammation
  Enlargement
Aneurysm of aorta
Bronchitis
Stomach
  Hyperchlorhydria

6

Circumflex neuralgia

7

Pectoral neuralgia

8

Axillary gland involvement

9

Intercostal neuralgia
Necrosis rib

10

Girdle pain–tabes
Diaphragmatic traction in coughing, sneezing and hiccoughing

11

Hepatic congestion
Hepatitis
Referred pain
  Pneumonia
  Pleurisy
  Vertebral diseases
Tabes
Subphrenic abscess
Nephroptosis

12

Gall bladder disease
Pancreatic disease
Gall duct disease

13

Renal colic
Ureteral colic

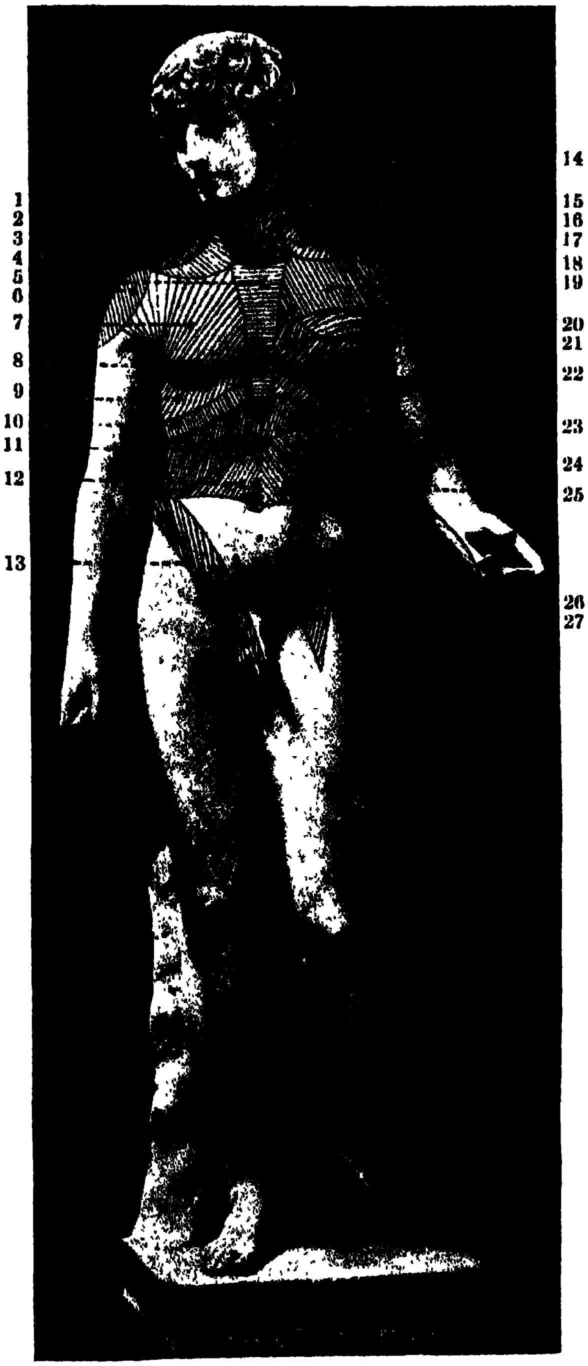

Fig. 76.—Pain Areas in Neck, Chest, Clavicular Region and Abdomen.

14

Parotiditis
Ear disease
Toothache

15

Tonsillitis
Pharyngitis
Ludwig's angina
Inflammation of base of tongue or submaxillary gland

16

Spleen
Stomach
Colon

17

New growths, glandular, etc.
Aneurysm, subclavian
Pulmonary tuberculosis

18

Deltoid bursitis

19

Lung disease
Pectoral neuralgia

20

Cardiac disease (angina pectoris)

21

Pancreatic disease
Cholelithiasis

22

Mastitis
Pericarditis
Stomach disease
Uterine and ovarian pregnancy (in female)

23

Stomach lesions
Pneumonia

24

Spleen
  Perisplenitis
  Displacement

25

Gastric disease
Pancreatic disease

26 and 27

Epididymis
Swollen and inflamed inguinal glands
Inguinal hernia

due (on the right side) to liver disease, or (on the left side) to disease of the colon or stomach (in new growth of which also search for metastatic glands in this region). In extrauterine pregnancy with rupture, pain, when present, is on the same side as the rupture; in colonic disease and diaphragmatic pleurisy, pain, as a rule, is on the diseased side. Pain over the shoulder is present in deltoid bursitis and also, in a wider area, in neuralgia of the circumflex.

NECK PAINS

When a patient complains of pain in the neck, the first idea suggested to the physician is that he is suffering from some inflammatory disease of the upper respiratory passages. This idea is increased almost to a certainty if, with the pain, there is also present an inspiratory stridor. It may be a sign of laryngitis, thyroiditis, or tracheitis. Should pain be felt only on turning the neck to one side or the other, and should one of the sternomastoids be in a state of tonic contraction, sternocleidoid disease or wry-neck is indicated (see Fig. 69). This tendency to lateral flexion and rotation is also seen at times in brachial neuralgia. Pain above the sternomastoid and below the inferior maxillary is found in tonsillitis, inflammation of the inferior maxillary gland, or in inflammation of the floor of the mouth, the so-called Ludwig's angina. Pain over the os hyoides or larynx is a sign of inflammation of the bone. In some cases an inferior maxillary neuralgia may be present. Pain just anterior to the ear, on the side of the face, indicates ear disease, parotitis, or diseased teeth (inferior maxillary).

SUMMARY

Pain in the back, over the entire vertebral column, indicates neurasthenia, traumatic spine or mediastinal disease; in the area between the scapula it indicates pericarditis, lung disease, diaphragmatic pleurisy and aortic lesions; over the scapula, lung involvement or pleurisy is indicated.

On the left side, between the vertebræ and the scapula, pain is present in aortic lesions and stomach disorders; at the apex of the scapula, on the left side, splenic disease is indicated; and, at about the same level on the right side (in many cases a little lower), liver disease is indicated. Pain generalized over the back of the chest may be due to myalgia, lung or pleural disease. Pain radiating around the side of the chest is due to intercostal neuralgia. By reference to Fig. 78, the local points of tenderness in brachial neuralgia and in the so-called diaphragmatic neuralgia

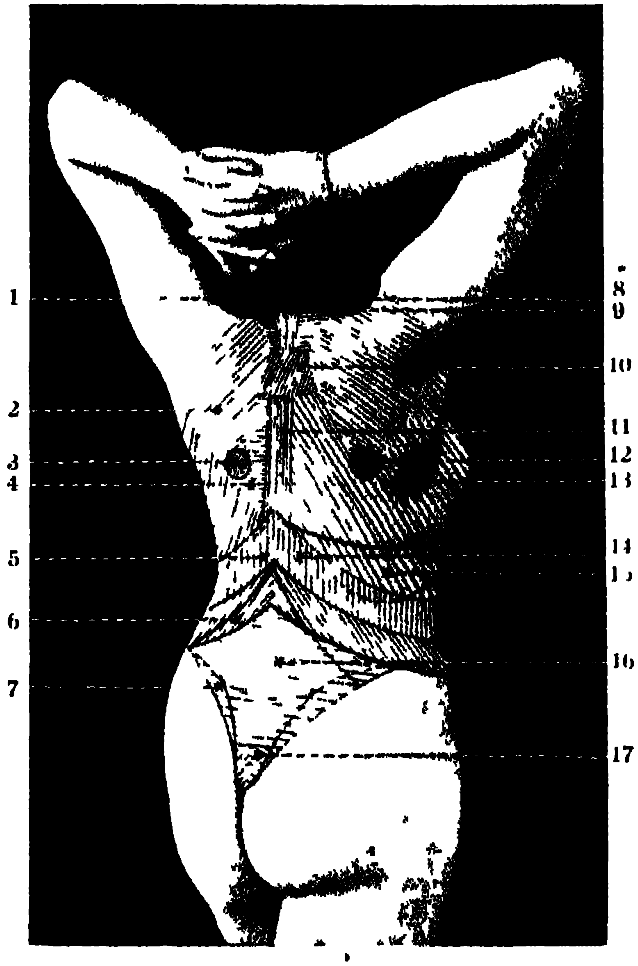

FIG. 77. PAIN AREAS IN THE BACK

1

Spleen
Pericarditis
Diaphragmatic pleurisy

2

Lung disease
Pleurisy

3

Splenic involvement

4

Aortic aneurysm (gnawing pain)
Stomach
  Overdistention
  Inflammation
  Ulceration
Liver

5

Vertebral disease
  Tbc. tumors fractures
Cord (crush, fractures etc.)
Liver

6

Kidneys

7

Sacroiliac disease

8
Liver gall bladder
9
Headache, back of head, pain radiating down the back from brain pressure
10
Pericarditis, lung disease
Diaphragmatic pleurisy
Aortic lesions
11
Vertebral and mediastinal disease
12
Liver disease
13
Lungs pneumonia pleural disease
Rib disease
Intercostal neuralgia
Pleurodynia
14
Tabes localized meningitis
15
Liver (perihepatitis)
Diaphragmatic disease
16
Kidneys (perinephritic abscess)
Colon impacted
Retroperitoneal glandular enlargement
17
Disease of coccyx
Cervicitis
Anal fissure
Hemorrhoids

are shown, as well as the points of tenderness in intercostal neuralgia and in angina pectoris.

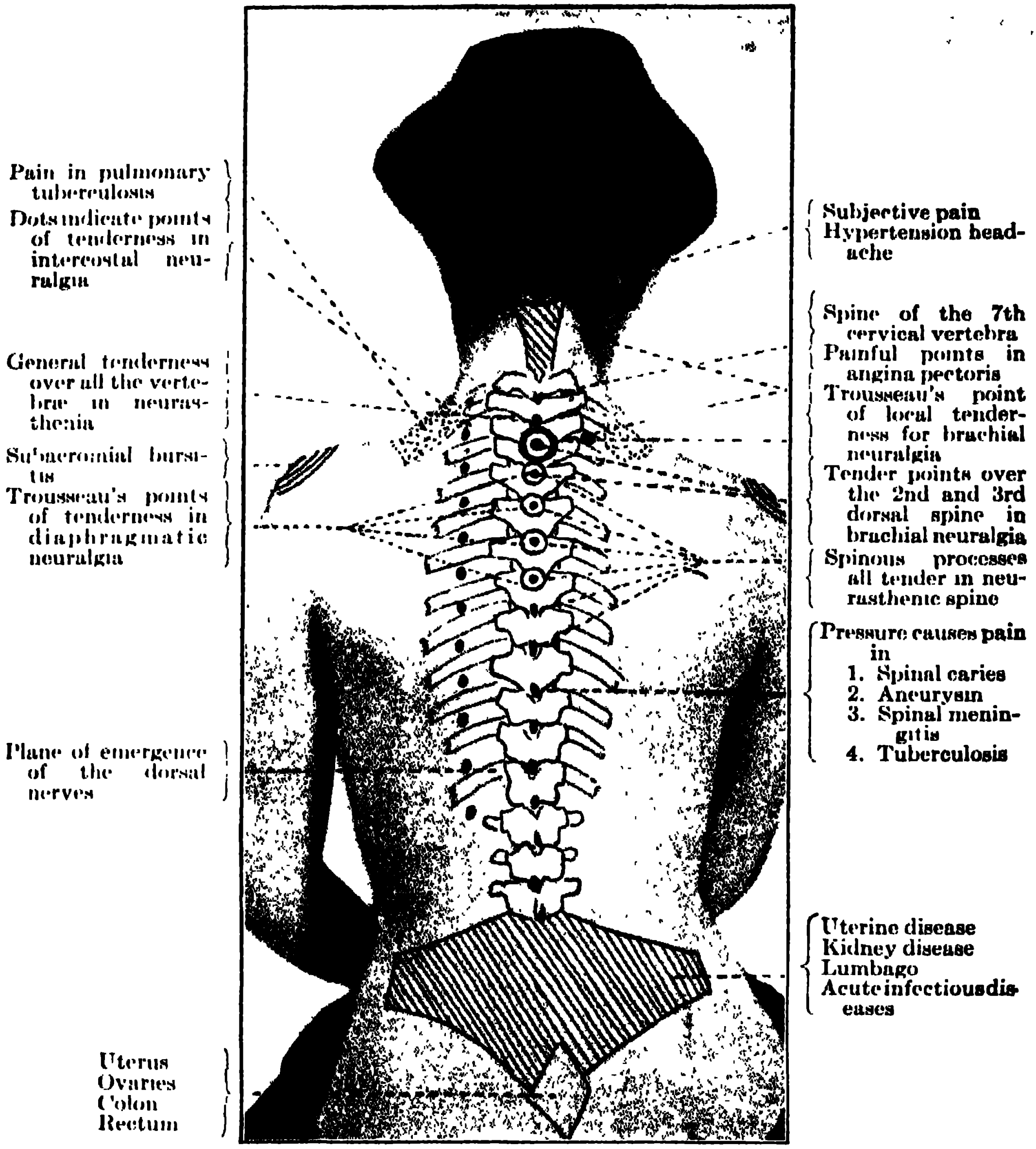
Pain in pulmonary tuberculosis
Dots indicate points of tenderness in intercostal neuralgia
General tenderness over all the vertebræ in neurasthenia
Subacromial bursitis
Trousseau's points of tenderness in diaphragmatic neuralgia
Plane of emergence of the dorsal nerves
Uterus
Ovaries
Colon
Rectum
Subjective pain
Hypertension headache
Spine of the 7th cervical vertebra
Painful points in angina pectoris
Trousseau's point of local tenderness for brachial neuralgia
Tender points over the 2nd and 3rd dorsal spine in brachial neuralgia
Spinous processes all tender in neurasthenic spine
Pressure causes pain in
1. Spinal caries
2. Aneurysm
3. Spinal meningitis
4. Tuberculosis
Uterine disease
Kidney disease
Lumbago
Acute infectious diseases

FIG. 78.—PAIN AREAS IN SPINAL COLUMN.

Lower down in the back, in the neighborhood of the lower ribs, are found the areas which are painful in perihepatitis and diaphragmatic disease, while a little lower is found the area in which pain is located in kidney disease. Lower still, and in the neighborhood of the sacrum, are the areas where pain is present in colon involvement, retroperitoneal gland, and uterine disease. In the entire small of the back are found the occupation-pain, uterine-disease pain, perinephritic-abscess pain, lumbago, and lumbar-abscess (tubercular) pain. In the same area, but extending over the sacroiliac articulation, is the pain of sacroiliac disease. Over the coccyx and adjacent regions is located the pain due to disease of the coccyx, rectal disease, and cervix disease. Pain over the buttocks, and running down the outer surface of the limb, is especially frequent in ovarian and broad ligament disorders.

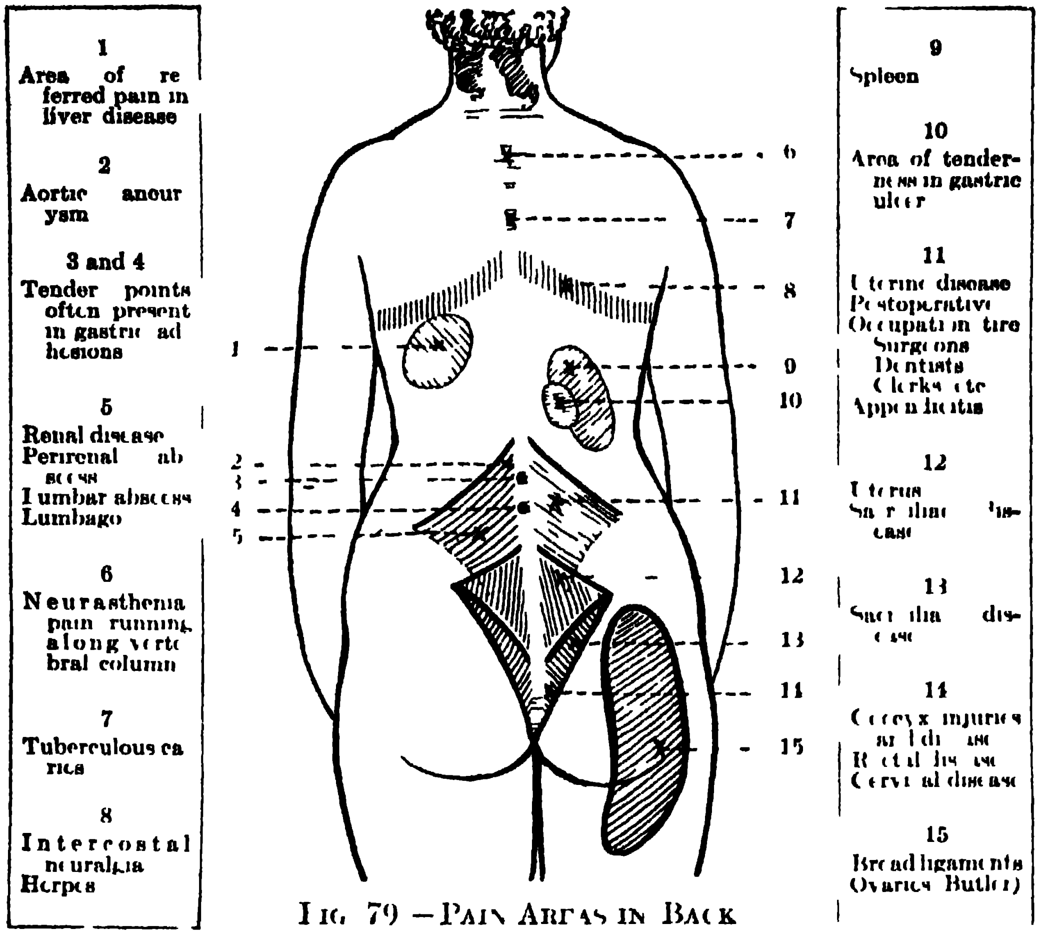

FIG. 79 —PAIN AREAS IN BACK

Pain in the inguinal region may be due to inguinal or femoral adenitis, and if it radiates down toward the foot it may be due to phlebitis, crural neuralgia, disease of the femur, femoral hernia, abdominal tumors pressing on the crural nerve (aneurysm, uterine or ovarian tumors, tuberculous abscess of the psoas).

Pain in a joint may result from rheumatism, tuberculosis, acute synovitis, stretching of ligaments, or floating bodies.

CHAPTER XV

THE SIGNIFICANCE OF PAIN IN DISEASE OF THE EYE[1]

When sensitive and sensory impressions falling upon the retina exceed a certain maximum in intensity they become disagreeable. If their intensity reaches a still higher degree the sensation provoked is painful. Just what are the threshold values for various forms of stimuli of the retina are not all determined. Thus, the action of very strong light on the eye causes a painful sensation, with blinding. Such sensations scarcely ever arise spontaneously. They are nearly always the result of the action of adequate stimuli which have been increased above the normal limits. These disagreeable sensations are to be distinguished from others due to irritation of the nerves of common sensation. In the descriptions to follow the latter will be simply called pain.

Under normal conditions an individual is not ordinarily conscious of the normal retinal stimuli, and if the existence of this organ intrudes itself upon consciousness this is usually a sign of a pathological condition. This consciousness is usually brought about through the medium of pain. As we do not possess any objective method for measuring pain, we must rely upon the information given by the suffering individual, which must be checked up by our own experience. Self-training, self-control, physical and psychical distraction are circumstances which considerably influence the intensity of this pain perception, increasing, diminishing, or even abolishing it completely.

The same uncertainty which exists in the estimation of the intensity of the pain dominates the characterization of the qualities of pains. In the same disease the same pain will not be described in the same way by several patients, and will be differently described by the same patient at different times. The pain may be described as blunt, dull, boring, burning, pulling, throbbing or tearing, but, unfortunately, there is no possibility of ascertaining whether the similar terms used by different patients describe similar sensations.

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[1] **By Docent Hans Lauber, M. D., and Olaf Ruttin, M. D., assistants of the Eye Clinic, Vienna.**

As far as the duration of pain is concerned, we are in a far better situation. We can more easily believe the correctness of statements which describe pain as continuous, periodical, intermittent, or periodically exacerbating. Under certain circumstances these characterizations can be of great diagnostic value.

ETIOLOGY

In examining the different factors that can cause or increase pain in the eye, or its surroundings, we find that they may be touch, pressure, atmospherical influences, temperature, light, and tiring of the eyes by work.

The topography of the eye and its adnexa points to the ramification of the first and second branches of the fifth nerve as the source of the tactile- and consequently also of painful sensations. The third branch is of but secondary importance. All the other nerves can be excluded from further consideration. As a consequence of the very extensive ramification of the fifth nerve, it is found that irritation of different branches of the nerve may produce a sensation of pain, or even other symptoms, in the ocular region. It is important to emphasize, at the very beginning, that irritation of any branch of the trigeminus may provoke a sensation of pain in its whole distribution, and, further still, reflex pain can be elicited in all those nerves that are in close anatomical or physiological relation to the irritated nerve—for instance, the intimate association of lachrymation to irritation of the trigeminus. Mechanical influences, acting upon the cornea, elicit lachrymation, just as easily as can the irritation of a tiny nerve stem in the pulp cavity of a tooth, or the irritation of the nasal mucous membrane, which are likewise innervated by the fifth nerve. Irritation of the bulbar terminal branches of the fifth nerve is generally accompanied by hyperemia, which extends from the immediate surroundings of the irritated place to the neighboring parts, and can lead to visible hyperemia of the conjunctiva. The numerous anastomoses of the fifth nerve with the seventh and the sympathetic explain the frequent reflex phenomena, such as sneezing, swallowing, pupillary dilatation, vasomotor and secretory disturbances. All these reflexes can occur in association with pain in the realm of the fifth nerve.

From a practical standpoint, pain is very important in a double sense, first, as a symptom of partial disturbance, which is often vague and allows many different explanations; second, as the patient's prominent subjective complaint, by the removal of which the physician can gain much credit.

LOCALIZATION OF PAINS

The exact localization of pains in the eye region may be of symptomatic significance, yet here we encounter many uncertainties. In a case of iritis, for instance, we firmly believe that the pain originates in the ramification of the fifth nerve in the iris itself, and yet many patients do not complain of pain in the eye, but in the bone surrounding the orbit. The pain in glaucoma has its source in the globe; nevertheless, many patients complain only of headache or hemicrania until the tenderness of the globe on pressure convinces them that the eyeball is the affected organ. Notwithstanding the fact that the localization of the pain may lead to false judgments, the following pages will attempt a diagnostic analysis of pain, based upon its localization.

The Eyelids. —The skin of the eyelids and their surroundings may be a source of intense pain in cases of inflammation. This pain may be spontaneous, and is generally very intense when the inflamed skin is touched. This kind of pain which is localized in the skin occurs in eczema, febrile herpes, herpes zoster, cases of phlegmon and abscesses of this region. In many cases the pain is associated with swelling of the tissues, so that the real focus of the disease can be found on palpation. In marked inflammatory edema of the lids one finds on touch an increased resistance of the tissue, which is considerably increased in some places. If the region of the internal canthus ligaments be the seat of tenderness to palpation the possibility of a beginning dacryocystitis or periostitis should be thought of. Pain and resistance at the margin of an eyelid suggest a hordeolum; superficial pain of the skin, accompanying movable resistance, points to the diagnosis of a furuncle or an abscess, whereas an immobile resistance is an argument in favor of periostitis. It should be remembered that inflammation or cicatrices in the region of the external canthus lead to marked edema of the eyelids, so that the localization of the painful spot and the accompanying resistance alone permits a diagnosis. Tumors of these regions, which are exceedingly painful, are occasional. Neuroma or neurofibroma are to be expected. Under certain circumstances ulcerated carcinomata occur. They are intensely painful to touch.

The pain in herpes zoster has a special character. It, at times, begins a few days before the appearance of an eruption; that is, during a period when the patient complains of general malaise. It is frequently impossible to explain such attacks of pain correctly until the appearance of the eruption shows the nature of the disease. The pain in herpes zoster may persist with the same intensity for weeks and months after the skin lesions are healed and the accompanying keratitis and iritis have subsided. Nightly exacerbations of the pain are not rare. The pain frequently irradiates into other branches of the trigeminus not apparently affected by the herpes. Simultaneously with the appearance of the intense pain there arises a hypo- or even anesthesia of the skin and superficial parts of the eye, so that the characteristic symptom complex of anesthesia dolorosa may appear. The sensibility returns slowly. Hyperesthesia is rare. These cases of herpes zoster represent the projection of a central lesion onto the peripheral endings of the nerves. Investigations of Barensprung, Head and Campbell, and Lauber have proved that the primary process is localized in the Gasserian ganglion. The skin, conjunctival and corneal changes are probably to be regarded as trophic lesions. In some cases (Eisenlohr) a peripheral neuritis has been found, so that not only lesions of the ganglion, but also those of the nerve are to be considered in herpes of this region.

From these statements it can be seen that the pain in herpes zoster is a true neuralgic pain, as it is caused by a lesion of the ganglion or of the peripheral portion of the nerve. It is of the character of acute inflammatory neuritis, caused by some toxic agent. It is a pathological process, occurring in the sensory ganglia, analogous to that in the motor ganglion cells in acute anterior poliomyelitis or polioencephalomyelitis. In addition to the virus, the nature of which is as yet unknown, other causes of herpes zoster exist. Such are traumatism, tumors, disease within the cavernous sinus, aneurysms of the ophthalmic artery, pulsating exophthalmos, poisoning by carbon dioxid and arsenic. All of these affect the fifth nerve, and are of etiological importance.

A disease which resembles herpes zoster in some ways is neuralgic herpes of the cornea (herpes corneæ neuralgicus of Schmidt-Rimpler). This is a periodically appearing affection, often recurring at the same hour of the day. The attack begins by pain in the supraorbital branch of the fifth nerve, and is characterized by an eruption of small vesicles in the distribution area of this branch. The whole attack passes off in a short time.

The pain which accompanies a febrile herpes of the cornea is due solely to the epithelial lesions, and does not show the typical neuralgic character of the two affections previously considered.

Several other forms of neuralgia of the same region are to be distinguished from typical trigeminal neuralgia, which is a persistent and very torturing disease. They show the same symptoms, but are secondary affections of the trigeminus. Acute neuralgias are caused by inflammatory conditions, such as orbital periostitis, empyema of the accessory sinuses of the nose, etc., and occasionally show relapses. Chronic neuralgias are due to tumor, keloids, or to chronic forms of periostitis and empyema. Neuralgia of the fifth nerve can also be caused reflexly by lesions in distant regions, as by caries of the teeth or in nasal affections. These can mislead the patient, as well as the physician. It is consequently necessary, in cases of neuralgic pain of the fifth nerve, to examine the entire distribution area of this nerve for causation lesions before making a diagnosis of idiopathic or primary (essential) neuralgia.

A diagnosis of neuralgia is generally based upon the tenderness of the nerve-stem to pressure. In the investigation of a case of neuralgia, pressure should be applied to the nerve exits; i.e., over the supraorbital foramen, the infraorbital, and mental foramina. This excessive tenderness, accompanied by spontaneous periodically exacerbating pain, is very characteristic. Tenderness to pressure is absent only exceptionally in neuralgia. This symptom alone, however, is not sufficient to make a diagnosis of neuralgia, as in hysteria, also, the branches of the fifth nerve are frequently tender to pressure. Furthermore, tenderness to pressure may be a symptom of a general polyneuritis and not of an isolated affection of the trigeminus. Especial attention should be called to the fact that neuralgic like pains of the trigeminus may be symptomatic of glaucoma, or they may be precursors of this disease, appearing a long time before the glaucoma can be recognized.

Another type of periodically returning pain in the trigeminus, though generally affecting only its meningeal branches, is hemicrania, or migraine. Here the so-called scintillating scotomata, with their characteristic features, are diagnostic. The attack begins with eye symptoms, and, during this period, the patient notices the scotomata with their luminous and generally moving margins. These attacks are then followed, as a rule, by intense unilateral headache, with frequent radiation of pain throughout the entire fifth nerve area. The cause of the phenomena is probably a vasomotor disturbance, which, acting upon the meninges, is felt in the peripheral branches of the nerve.

A very rare affection, likewise characterized by intense hemicrania, is a recurring third nerve palsy—ophthalmoplegic migraine. Intense hemicrania introduces the attack, to which ptosis and almost total immobility of the eye, nausea, or vomiting are added. Such attacks persist for from a half a day to two days or more, and may recur at irregular intervals of a few weeks or months. During the intervals of the attack the third nerve paralysis recedes, but may not completely disappear.

Surroundings of the Eye.—Tender pressure points, so characteristic of neuralgia, may exist in other affections of the surroundings of the eye. The cause of indefinite pain in the head, especially of dull pain in the forehead, can occasionally be found by careful palpation, which reveals the nerve tenderness at a certain place. Tenderness of the bone to percussion and tenderness in the region of the trochlea are found in many cases of acute or chronic affections of the frontal sinuses and the anterior ethmoid cells. Thus, one may be guided to a correct diagnosis. Such cases can be differentiated by the existence of delimited sensitive areas from those other cases where the bone is sensitive throughout to pressure or percussion, and at the same time is diffusely thickened. These latter symptoms lead to the diagnosis of periostitis and osteoperiostitis. Indolent thickenings of the bone are but rarely due to inflammation (lues, tuberculosis), and, as a rule, represent tumor or protrusion of the bones by meningo- or meningoencephalocele.

Conjunctiva and Cornea.—Pain in the conjunctiva and its corneal continuation is of the greatest interest to the oculist. The abundant end ramifications of the nerve plexus of the superficial layers of the cornea penetrate as far as the basal cells of the epithelium and explain the great sensitiveness of this organ, as well as the great intensity of the pain in superficial lesions (erosions) of it. The conjunctiva is much richer in nerves than other mucous membranes of the body. Inflammatory or traumatic irritation of the nerve endings in the conjunctiva gives rise to very severe pain, alike torturing to the patient and difficult for the physician to abate. Great sensitiveness to thermic, atmospheric, and light influences is present, and exposure to these increases the pain to the highest intensity. While there is not the least doubt, so far as thermic and atmospheric stimuli are concerned, that the nerve terminations in the conjunctiva and cornea can transmit pain stimuli and cause such reflex disturbances as lachrymation and blepharospasm, yet light can also give rise to painful stimuli, and it is not so easy to determine how it acts and causes pain in corneal and conjunctival lesions.

It is a fact, however, that in corneal erosions or in other superficial lesions of the cornea, likewise in iritis, there exists a great sensibility to light (photophobia), even when the patients keep their eyes closed, thus excluding atmospheric and thermic influences.

In iritis, whether primary or secondary to keratitis, one is inclined to attribute the pain caused by light to reflex contractions of the sphincter, and to the irritation (on pupillary dilatation or contraction) of the sensory nerves in the stroma of the iris. But if the iris is normal, and its contractility is suppressed by means of a mydriatic, it can no more be considered as a source of pain, and other causes of the corneal irritation to light (photophobia) must be sought. Wilbrand explains photophobia as follows: "Exposure to light leads to the formation of products of metabolism in the pigment of the retina; if the formation of such products becomes increased, they may cause pain in the ciliary nerves of the choroid, which contain filaments of the fifth nerve. If those nerves are in a condition of pathological irritation, even small quantities of these products of katabolism can cause considerable pain. This theory, however, does not explain why the instillation of cocain into the conjunctival sac, in quantities which can act only upon the superficial endings of the nerves, can in many cases quite suppress the photophobia. This would be in favor of an explanation which attributes light sensibility to the endings of the trigeminus in the cornea and conjunctiva, analogous to the direct action of light upon the iris. This theory is, however, not satisfactory.

Hyperemia of the conjunctiva, infiltration of both conjunctiva and cornea, detachment of the corneal epithelium in the form of vesicles and blebs surely lead to mechanical and possibly also to toxic irritation of the nerve endings. This explains why the pain is so very severe in conjunctivitis and superficial keratitis.

Superficial traumata, which expose the superficial and subepithelial nervous plexi, are exceedingly painful. Deeper wounds, which penetrate the substance of the cornea and sever the nerve-stem, are less painful.

In an irritative condition of the cornea and conjunctiva, tear-secretions retained in the conjunctival sac can cause considerable complaint. The accumulation of tears in the conjunctival sac, when an eye is kept under a bandage after an operation, may cause great discomfort, and even pain, which can be instantaneously relieved by removing the bandage and opening the eye. Small quantities of mucus or muco-pus, on the surface of the eye, are perhaps the cause of the sensation of a foreign body in conjunctivitis.

In cases of gonorrheal or diphtheritic conjunctivitis the edema of both conjunctiva and lids may lead to such stretching of the lid that it can be the source of pain. However, this is easily removed by simple canthotomy.

After foreign bodies of the cornea or conjunctiva have been removed the sensation of their presence frequently persists for a few hours and disappears, together with the subsidence of hyperemia and the reparation of the tissue lesions. Observations of this kind prove that both hyperemia and the pressure of an almost imperceptible exudate are able to irritate the nerve termination to a high degree and cause pain.

In erosions of the cornea the pain often has a recurring character. According to von Reuss, two types of this affection can be distinguished. In the first slight pain appears on first opening the lids after sleep, or after they have been kept closed for a long time. This soon ceases. In the second type, after a period of apparent health, attacks of pain occur, having the same character and intensity as those following the original trauma. They are caused by a plainly visible loss of epithelium in the same place where the primary injury had originally led to the loss of substance. Both types of the affection are the consequences of an abnormal condition of the epithelium established by the trauma. Close examination of the cornea with a lens, or by the ophthalmoscope, show minute opacities in the epithelium. In the first group of cases the corneal epithelium, which during the night is in close contact with the tarsal conjunctival epithelium, sticks fast to the latter and is torn off when the eye is opened. In the second group of cases (the recurring erosion in a strict sense) the epithelium degenerates, is cast off, and exposes the nerve plexus lying in the superficial layers of the cornea.

The pain associated with corneal herpes and punctate superficial dendritic and stellate keratitis is due to similar causes. Corneal ulcers of various types all expose the nerve plexus of the cornea, and can, therefore, cause more or less pain. The pain becomes more intense when the exposed nerves are irritated by the moving lids. For that reason a bandage is applied to prevent the movement of the lids, and thus to diminish the pain. It cannot relieve it completely, as the infiltration of the tissues exercises pressure upon the nerves and stretches them. Toxins produced by bacteria also cause painful irritation of the corneal nerves. Sudden pain arising in a case of ulcerating keratitis frequently indicates perforation of the ulcer. The chief cause of pain in perforation of the cornea is the mechanical irritation of the iris. If the iris prolapses and cicatrizes, sudden and intense pain may again arise. This is a symptom of secondary glaucoma. The severe pain which frequently accompanies deep keratitis is largely due to a concomitant iritis.

Referred pain is also present if the ulcer extends into the deeper layers of the cornea. The area of reference is in the frontonasal area, and also to some extent in the midorbital (Head). This referred pain is probably due to a deepening of the anterior chamber. Should a true cyclitis be present, the pain is referred further to the side in the forehead than in corneal ulceration, the midtemporal area being, as a rule, concomitantly involved with the midorbital.

The Iris and Ciliary Body. - The existence of a dense nervous plexus in the iris and the ciliary body fully explains the severe pain found in diseases of these parts. The specific etiology of iritis and iridocyclitis is also a factor in the origin of iritic and cyclitic pain. Its importance, however, should not be exaggerated. The pain is frequently continuous, and may be localized in the eyeball itself, or in the surrounding bones, even in the entire half of the head corresponding to the affected eye. As in many other diseases, so in iritis and iridocyclitis exacerbation of the pain is observed toward the end of the night or in the early morning. This is not only characteristic of syphilitic affections, but occurs in the same way in rheumatic and traumatic cases of iritis. In rheumatic iritis, more often than in those due to other causes, severe pain during the night is a sign of a relapse or of an exacerbation of the inflammatory trouble. Examination of the eye the next morning shows fresh fibrinous exudate in the anterior chamber, or the presence of a fresh hyperemia. Such acute attacks of pain are usually of short duration. Metastatic gonorrheal iritis is a type of iritis which causes the most intense and obstinate pain. The referred pain, as a rule, is in the frontotemporal, maxillary and temporal areas. Should the tension in the vitreous chamber rise, the pain has a tendency to be referred further back, and also, in some cases, the teeth of the upper and even of the lower jaw may become painful and very sensitive to pressure.

Rest in bed, atropin, warm applications, dionin, and diaphoresis are serviceable for all forms of iritis. If the pain is very intense aspirin, pyramidon, or morphin must be given, and even these analgesics may prove insufficient to relieve the pain. In chronic iritis and iridocyclitis the pain is generally very moderate. Circumscribed areas in the region of the ciliary body, which are tender to pressure, can be sometimes detected. They probably correspond to small inflammatory foci which do not cause any other clinical symptoms. It is important to ascertain their presence, as they direct attention to the possible recurrence of the disease.

A sudden exacerbation of pain in an acute or a chronic iritis should always arouse the suspicion that a secondary glaucoma is developing. The pain caused by such an attack of secondary glaucoma can reach the highest possible degree. The increase of intraocular tension is diagnostic for acute glaucoma, although the differential diagnosis between a primary and a secondary glaucoma may be very difficult, especially when the cornea is dull and opaque.

A painful condition, which closely resembles iritis, and which is in direct contrast to glaucoma, is an acute hypotonia of the globe, complicating detachment of the retina. Hypotonia of this kind can exist without any pain. In very pronounced and acute cases, however, pain appears. To this subjective symptom there corresponds an objective change, consisting of a slight ciliary injection of the globe, a deepening of the anterior chamber and a tremulous condition of both iris and lens. The vitreous is generally very turbid, and permits only indistinct recognition of the increase of a preëxisting or the first appearance of a retinal detachment which previously had not existed. The pain, as a rule, is mild and, together with other symptoms, slowly disappears.

In the course of retinal detachment there also occurs another painful process, i.e., an iritis, which, similarly to the detachment, is a consequence of the high myopia. If pain appears in the eye affected with posterior staphyloma iritis might be present. Such myopic iritis seldom appears in posterior staphyloma without involvement of the retina, and may be a precursory symptom of this grave affection.

Sclerotic Coat.--Areas, tender to pressure, similar to those previously described as occurring in chronic iritis, but corresponding to hyperemic and swollen areas of the sclerotic, are characteristic for scleritis. This affection may cause violent, spontaneous pain, but may also be absolutely indolent. It is not exactly known why some cases of scleritis are very painful and others are not. This certainly does not depend upon the etiology, as both forms may be caused by the same etiological factors. Anatomical investigation (Oatman) may explain it. In some cases the ciliary nerves, as they pass through the foci of the scleritis, remain normal; while in others they are infiltrated by leukocytes. The infiltrated nerves show the anatomical picture of a neuritis, and this is probably the cause of the pain.

Inflammatory foci of the scleritis may be invisible, on account of chemosis. If such is the case, palpation of the globe will easily disclose the situation of the sclerotic foci. A sclerotic infiltration, situated under one of the muscles, or at a muscular insertion, will be irritated by contraction of the muscles and cause pain in movements of the eye.

Similar pain following eye movements may be the sign of rheumatism of an eye muscle. The diagnosis of this condition is based on the subjective symptom of pain without any visible changes. Diplopia as a sign of impaired movement is, however, not present in these cases of rheumatism.

Choroid, Retina and Optic Nerve.—Inflammation of the internal membranes of the eye, choroid and retina, as well as inflammation of the optic nerve, generally does not give rise to pain. Acute retrobulbar neuritis is an exception. Dull pain in the orbit, increasing on extreme or violent movement of the eye, or on pressure upon the globe, and associated with rapidly increasing amblyopia and negative ophthalmoscopic findings, is the chief symptom upon which the diagnosis is founded. A similar deep pain on pressure occurs in posterior scleritis, which sometimes shows an intermittent exophthalmos, and also in periostitis or empyema of the posterior ethmoidal cells.

Bulb.- Pain originating in phthisic eyes deserves especial attention and may arise from different causes. In most cases it is due to increase of pressure of the process which originally caused the phthisis, and is of the greatest importance, because a reappearance of a previous inflammation may produce a sympathetic affection of the other eye. Therefore, it cannot be expressed too strongly that all phthisical globes which cause spontaneous pain ought to be removed.

Up to the present time no symptom is known permitting a differential diagnosis between an eye apt to induce sympathetic ophthalmia from those which are harmless. Great attention must be given to the other eye. Dull pain in the healthy eye may be the first symptom of a sympathetic trouble. The suspicion of a beginning process of this nature will be aroused, especially by the appearance of photophobia, ciliary hyperemia, and diminution of the range of accommodation. These symptoms, which have been described as sympathetic irritations, may precede the outbreak of an iridocyclitis for a varying period of time. Sympathetic ophthalmia may also begin without irritative symptoms.

Sunken globes may become painful also from other reasons. Such are ossification of the choroid, which causes pressure upon the branches of the ciliary nerves, and folding of the sclerotic, which acts in the same manner. Attention may be directed to the fact that, even after the enucleation of a globe, the trunk of the optic nerve or its surroundings may be very painful to pressure, and is an indication for the resection of these parts in order to enable the patient to wear a shell. The cause of this pain is a neuroma of the ciliary nerves.

Glaucoma.—The most violent pain which can exist in eye diseases is that found in acute glaucoma. The increase of intraocular tension and the consecutive pressure upon the nerves in all the tissues of the globe are given as the explanation of this pain. Radiation of pain into different distributing areas of the trigeminus is quite frequent, and has caused the condition to be mistaken for a neuralgia, a hemicrania, a toothache, or, when vomiting is present, even for a meningitis. It is unnecessary to analyze the nature of an acute attack of glaucoma. It should be remembered that inexplicable pain in the first branch of the fifth nerve is frequently a symptom of glaucoma; either prodromal or the developed disease. No doubt neuralgia may precede the outbreak of an acute glaucoma by months or years. This pressure may be reduced (with consequent relief of pain) by miotics. The diminution of intraocular pressure due to miotics may be considerably enhanced by the use of one per cent. solution of morphin, used as a collyrium simultaneously with the miotics. Eserin is excellent in subduing pain caused by glaucoma. If, however, it is instilled into a normal eye it is liable to cause considerable pain. This is due to the compression of the nerve fibers by the tonic contraction of the sphincter of the pupil. This pain may be quickly removed by the use of a mydriatic.

Iridectomy and other operations devised to replace iridectomy alleviate the pain rapidly when they reduce the ocular tension. If after an operation for glaucoma intense pain arises, or an increase of pressure is noted, it is a symptom indicating the malignancy of the glaucoma, and forebodes the loss 'of the eye. If the eye is blind and painful from glaucoma one may attempt to relieve the pain by anti-glaucomatous operations, if they are possible; otherwise, there remains only opticociliary neurotomy or enucleation of the globe. The operation first referred to is a dangerous undertaking, as its results are doubtful, and in many cases it must be followed by enucleation.

Panophthalmitis.--Pain in panophthalmitis is caused in a similar manner to that of glaucoma. The presence of a focus of purulent inflammation in the globe, with the consequent pressure, explains the painfulness of the disease. That the simple opening of the globe by incision or spontaneous perforation at once considerably relieves the pain proves that increase of pressure due to the purulent exudation plays a great part in the etiology of pain in panophthalmitis.

Asthenopic Disorders. An entirely different group of painful conditions is met with in the asthenopic disorders and the closely related cases of eye-strain. In both accommodative and muscular asthenopias, whether the latter be caused by exophoria or insufficiency of convergence, the phenomena are blurring of objects and a dull pain in the forehead. This is accompanied by a feeling of heaviness and pressure in the eyelids, lacrymation and a sensation of heat in the eyes. If, in spite of these symptoms, the eyes are used for work, headache may appear and continue even during the next day. Asthenopic disorders manifest themselves, as a rule, in the late afternoon or in the evening, when the muscular apparatus is tired by the day's work. Proper glasses or prisms can totally suppress the trouble, or at least alleviate it considerably. In muscular asthenopia stereoscopic exercises can also be of benefit.

How far a low degree of astigmatism may cause trouble is not quite determined. Most of the European oculists are sceptical in regard to this question, whereas English and American oculists, especially the latter, attribute a great number of subjective disorders to uncorrected or insufficiently corrected astigmatism. They also have created and developed the term "eye-strain," to which disturbances in all parts of the organism are ascribed. Disturbances due to hyperphoria are less frequent than simple asthenopic phenomena, and differ from muscular asthenopia in exophoria, in that they trouble the patient not only in close work, but cause incessant aching. The prescription of corresponding prisms with the apices upward and downward suppresses such disorders promptly.

To Bielschowsky we owe the knowledge of a rare group of painful disturbances related closely to asthenopia. This author has discovered cases of disturbed innervation of binocular vision leading to considerable subjective disturbances and simulating squints. Their treatment either by operation or drugs is rarely successful.

In hyperopics the over-strained accommodation leads to asthenopia. Disturbances caused by straining of the accommodation do not occur in myopics, who, nevertheless, experience disagreeable sensations. Myopics of the middle and higher grades frequently complain of pain in their eyes when they use them for close work. This pain, which is intermittent but not severe, may yet be very troublesome to sensitive and neurasthenic individuals.

No generally accepted explanation of this kind of pain exists, but it would seem quite plausible to connect it with the process of stretching of the sclerotic, which may also affect the nerves lying in the sclera. This pain cannot be influenced by the wearing of correcting glasses, or by the extractions of the lens for removal of the myopia.

CHAPTER XVI

PAIN IN DISEASES OF THE EAR[1]

It passes as current fact among the laity that ear pains can scarcely be surpassed in severity by any pain elsewhere in the body. Relief may be secured from pain occurring in any part of the external or middle ear, but not from pain of labyrinthine origin.

External Ear. Trauma of the external ear is scarcely more painful than trauma in other parts of the body, but it may be followed by two troublesome conditions, namely, othematoma and perichondritis. Othematoma is an exudate of serous, bloody fluid between the cartilage and perichondrium of the ear. It results from a blow, especially one from a fist. Consequently, we find it frequently among prizefighters, and perhaps most frequently among the Japanese wrestlers, because they use the head and neck against the head of an opponent, and in this way the ear often becomes subject to very great pressure, giving rise to the abovementioned exudate. It also is frequently seen among patients suffering from acute mental disturbances.

The pain in hematoma is usually trifling. It is mostly of a dull, aching character, worse at night. If, however, the othematoma becomes infected through unskilful surgery, a very painful perichondritis may follow.

Such a perichondritis arises sometimes, also, after a radical operation, as a result of infection of the cartilage. This cannot always be avoided in plastic work upon the external ear. If the bacillus pyocyaneus is present in the middle ear secretion, this germ, which has a fondness for attacking cartilage, may bring about a perichondritis. In fact, one can always grow the bacillus pyocyaneus in pure culture from the perichondritic secretion. Such a perichondritis advances very slowly, and lasts about four weeks, when the disease has reached its highest point. The suppuration then ceases, and the cartilage begins to shrink. Unfortunately, early and energetic incision does not shorten its course. During the period of development, to the beginning of the shrinking of the cartilage, extraordinarily severe pains exist. It often requires much persuasion to convince the patient that this distressing condition is not dangerous.

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[1] By Dr. Ruttin, assistant in the Ear Clinic of the University of Vienna.

Of the tumors of the external ear, carcinoma and sarcoma sometimes give rise to severe pains, but they often run a painless course. The same is true of the inflammatory granulomata of lupus and lues, in which the slight pain may be completely overshadowed by the itching.

Pain of the external ear due to frostbite is especially noteworthy. It is peculiar in that it is likely to recur with every return of cold weather. The previously frozen parts often begin to be painful again, even with a moderate fall of temperature.

A very painful disturbance in the pinna, which is, to be sure, only a symptom of another disease, is herpes. The pain begins even before the appearance of the herpetic vesicles, and continues usually until they vanish. Gouty nodules, which have a preference for the helix margin of the pinna, may be the cause of pains which are of a very unstable and changing character, a peculiarity of gouty nodules in general.

External Auditory Canal.—The external canal, with its numerous hairs and glands, is directly predisposed to furunculosis. The frequency of middle-ear suppuration, and the circumstances that such a condition, after only a short existence, in most cases shows a secondary infection with pyogenic staphylococcus, carries with it the probability that during the necessary cleaning manipulations of patient or physician the hair follicles become inoculated, a procedure which, according to the researches of Schimmelbusch, Garré and others, brings about furunculosis with tolerable certainty.

Furuncle of the external canal manifests itself through a special painfulness, because the pus, on account of the closely woven, subcutaneous, connective tissues, is held under a high degree of pressure. These pains are of a boring, sticking, throbbing nature, and radiate, by preference, toward the teeth. Therefore, the patient can take only a very limited amount of nourishment, since every movement of the mouth increases the pain. This is due to the fact that the head of the inferior maxilla lies against the anterior wall of the external auditory canal, and movements of the jaw joint are accompanied by movements of the adjacent aural tissues. The pain usually subsides with the rupture of the furuncle, or with its opening.

The pain of diffuse inflammation in the external canal, the so-called otitis externa diffusa, is of longer duration, and much less certainly influenced by operation.

Foreign bodies in the external auditory canal cause pain usually only by penetration, by wounds brought about by unskilful attempts to dislodge them, or by the swelling or growing of the foreign body in the ear. Peas, beans and fruit kernels remaining for some time in the canal swell, and cause a very noticeable pressure upon the canal wall, thereby producing more or less pain. The larvæ of the large meat-fly ("blue-bottle fly"), developing from eggs laid in the canal, often attain greatness, both in number and in size. They may cause such pressure upon the external canal that it becomes widened to the breadth of a finger. Since these maggots are provided with sharp hooks at the ends of their bodies, and seek to attach themselves by sticking these hooks into the skin, the pain which they produce is extraordinarily severe. This becomes still greater, because the worm masses are always in motion, and consequently the pain is of a continuous, changing, undulating character. I have observed such a case, in which twenty-six maggots had brought about a considerable widening of the canal, with very intense pain.

In lesions of the middle ear the patient assumes a position in which the ear of the affected side rests in the palm of a supporting hand, the elbow resting on a table, as is illustrated in Fig. 80.

Tympanum.—Pains may originate in the drum membrane. One often speaks here of a myringitis bullosa. This is, however, not a bacterial invasion, but is only a herpes of the drum. Bacteriological examination in large numbers of such cases showed the vesicles to be sterile. The sudden beginning of the pain is very characteristic for myringitis. Often the patient is awakened at night by a sudden, severe, sticking pain in an ear previously entirely sound. The pain lasts as long as the vesicle remains, but ceases just as suddenly as it began[1]

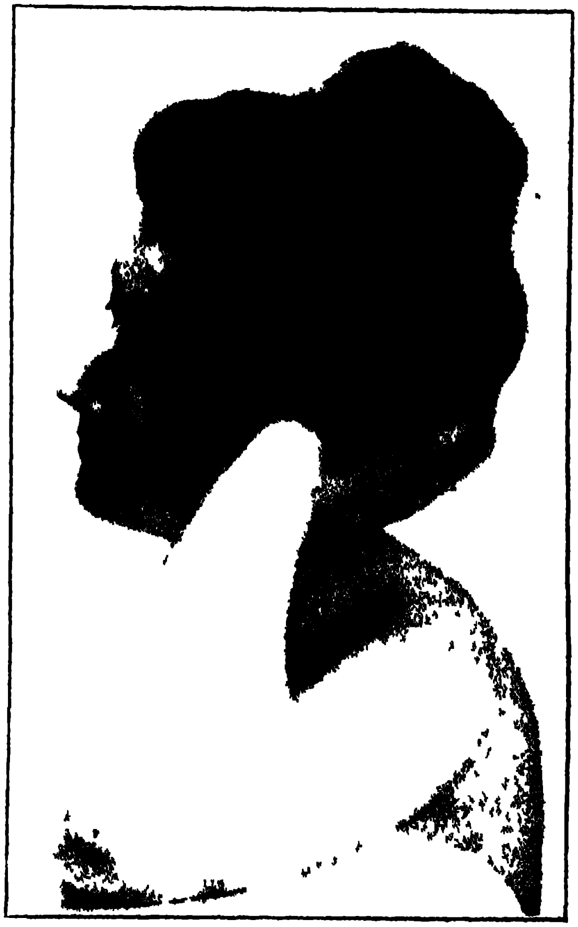

Fig. 80.—Posture Assumed in Earache

In lesions of the external meatus from the tympanum outward the pain is localized to the diseased area, but from the drum inward the pain is, as a rule, referred to a distant area, the most common reference area being the hyoid, which has two points of maximum tenderness, the first in the meatus and the second just behind the angle of the jaw. These areas are also associated with the tonsil, the posterior teeth of the lower jaw, and the lateral aspects of the tongue (Head). When the tension in the middle ear is raised pain may also be referred to the vertical and parietal area of the scalp. (See pages 293 and 294.)

Middle-ear Disease.—Acute Otitis Media.—Most marked are the pains of acute middle-ear inflammation. Here they are not limited to the membrana tympani, and are most severe until perforation of the drum takes place. We must, however, differentiate two kinds of acute otitis, namely, that caused by capsulated bacilli, and that caused by noncapsulated bacilli. While in the first type the pain is usually trifling in nature, and only "sticking" in the first day of the disease, as in middle-ear catarrh, the second type, caused by noncapsulated cocci, calls forth the most capricious and troublesome symptoms. The pains begin with moderate intensity and increase, within two or three days, to quite unusual severity. They are, as a rule, of a boring, sticking or tearing nature, and reach the greatest degree when the drum membrane becomes deep red, shows no details, and is nearly ready to rupture at some markedly bulging spot. After rupture the pain for the most part ceases. Obviously one can shorten the patient's sufferings by carrying out artificial rupture of the drum through incision (paracentesis). It must be regarded as an unfavorable sign, if, after perforation of the drum, the pains do not immediately subside. In such cases the mastoid process is likely to be included, and if this comes to pass spontaneous pains of greater or less severity manifest themselves. However, this symptom may be completely lacking, or may only be elicited by pressure, either upon the mastoid tip or over the antrum, in which latter case the mastoid cells are undoubtedly involved. To be sure the propagation of the inflammation to this degree must depend upon the anatomical structure of the mastoid process. A pneumatic mastoid is always affected in the beginning of an acute otitis, and this is the reason why tenderness at the tip in such cases is so frequently seen. But this inflammation may at any stage retrogress without going on to suppuration and, therefore, in the beginning of an acute otitis this symptom has no pathognomonic significance. If, however, the tenderness or the spontaneous pains last a relatively long time, or if, after having once vanished, they reappear, then it is probable that we have to do with an abscess in the mastoid process, and in this regard the symptom becomes of great importance with respect to operative interference.

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[1] Hunt, of New York, has shown that this type of herpes is usually associated with disease of the geniculate ganglion.

CHRONIC MIDDLE-EAR DISCHARGE causes, as a rule, no pain;

but pain may arise, of course, as a result of an acute exacerbation, or if the perforation in the drum is so small that opportunity is given for retention of pus. Sometimes chronic middle-ear suppuration, which otherwise would give no pain, is, when accompanied by cholesteatoma, subject to manifestation of severe pain.

COMPLICATIONS OF MIDDLE-EAR DISEASE.—If acute or chronic middle-ear suppuration becomes complicated by extension of the inflammation to neighboring regions, then the pain thus produced is usually quite significant, especially if suppuration takes place in the mastoid, whereby the mastoid cells are broken down and the excavated interior of this bone becomes filled by pus, which, through gradual accumulation, exerts great pressure. If this pus breaks externally through the bone cortex, it can dissect the periosteum free from the bone to a very great extent. We then find a large swelling behind the ear, which is covered by a much-reddened, very tense epidermis, giving rise to great pain. This swelling may become so great that the entire half of the head is involved, especially in badly neglected cases. This subperiosteal abscess formation is very frequent in children, because the pus passes through the open fissura mastoidea in a very short time, and then lies directly under the periosteum; but here, on the other hand, instead of producing pain, the pain may be actually lessened after penetration to the periosteum for a time, at least, through relief of pressure within the mastoid shell.

If, however, the pus burrows inward, the dura becomes exposed through destruction of bone, either in the posterior or middle fossa, according to the direction which the destructive process takes. The tough dura and, in the posterior fossa, the sinus lateralis are fairly resistant structures, and may often be surrounded by pus for a long time without becoming especially affected. They become covered with granulations, which serve further to protect them, and thus are brought about the conditions known as pachymeningitis externa, or periphlebitis of the lateral sinus, as the case may be. With this disease-picture at hand, the pain is likely to be of a trifling, ill-defined, dull nature, but if the pus extends outward between the dura and the bone, or between the sinus and the bone, we have the picture either of an extradural or of a perisinus abscess. We speak of a "closed" extradural abscess if the opening through which the pus has penetrated to the dura is so small as to be nearly undemonstrable; but if, on the other hand, the communication with the purulent mastoid cavity is greater, we speak of such a condition as an "open" extradural abscess. Naturally the pain in a closed extradural abscess is much more severe than in the open type. If the pus spreads out toward the tip of the petrous portion of the temporal, then periorbital pains often arise, which Neumann holds to be characteristic for this type of extradural abscess. On the contrary, if the abscess spreads more laterally in the middle fossa of the skull, pain and swelling in the temporal region near the zygomatic process simultaneously arise, as Ruttin has described.

Perisinus abscess may also cause very severe pain, especially if the pus collects in the bony sinus groove between the membranous and bony sinus walls, where it often remains under such high pressure that, upon opening the mastoid process, it gushes forth in a pulsating stream. Still greater may the pain become, if, besides the pus, gas forms (gas abscess), and raises the pressure to a very high degree. Perisinus abscess, like extradural abscess in the posterior fossa, causes a more or less severe headache in the occipital region. If the suppuration destroys the dura mater, then intradural suppuration, meningitis, temporal lobe abscess, cerebellar abscess, or sinus thrombosis may arise.

Intradural suppuration is such a rarity, and so seldom clinically pure in type, that with respect to pain as a symptom it offers very little that is characteristic. On the contrary, otogenic meningitis may produce a tolerably pronounced picture, since in it the pain is extraordinarily intense, of a sticking or tearing character, and accentuated in its last phase. I am accustomed to describe this to my students in the following manner: The location of this pain varies according to the extension of the meningitis. The basal type usually causes occipital or frontal headache, but the head type, that is, the form of suppuration which spreads out over the convexity of the brain, produces pain at the vertex of the skull. Characteristic, also, of meningitis are the remissions of pain, great suffering being often followed by a period of comparative ease and comfort.

Brain abscesses may also exist in the middle and posterior fossæ. Headache is seldom lacking in these cases, and may be referred, in both cerebellar and temporal-lobe abscesses, to the frontal or occipital regions. In temporal-lobe abscess it is not seldom localized at the vertex of the skull, but in both temporal-lobe and cerebellar abscesses the pain is usually limited to the half side of the head—hemicrania.

Middle-ear Catarrh. Middle-ear catarrh is a frequent cause of pain, especially in children. This pain, to be sure, is not especially intense, but may, through its sticking character, be quite disagreeable. It seems that such pains are induced through the strong retraction of the membrana tympani; at least, this is true of those cases in which the drum is markedly retracted, for they vanish after inflation of the tympanic cavity, or after aspiration through the external auditory canal. High-grade inveterate catarrh, with maximal retraction of the drum, which is of a milky color, also causes pain, which is not, however, to be influenced through Politzerization, catheterization or massage, because the drum is fixed in the retracted position and cannot be corrected through these manipulations. In these cases the pain, nevertheless, ceases immediately if one introduces a hook with a straight shank just in front of the hammer and draws the entire membrane outward, after the method which Ruttin has described.

Otosclerosis. In this disease, which consists of pathological changes in the bony labyrinth capsule and which has an exquisite hereditary anamnesis, but whose etiology is still unknown, pains are seldom to be found. However, there exist, sometimes, in addition to diminished hearing, noises and manifold paresthesias localized or diffused through the entire ear tract, as well as painful sensations in the external canal, and in the surrounding structures.

Labyrinth.- Whether pains of distinctly labyrinthine origin are to be recognized or not has hitherto not certainly been proven.

However, pains in labyrinth disease scarcely come into consideration in relation to the other extraordinarily troublesome and distressing symptoms, such as difficulty of hearing, noises, dizziness, vomiting, etc.

Referred Pains.—First of all, there are pains due to diseased teeth, which may so closely simulate aural pains that a typical disease-picture is described as otalgia excarie dentium, since a bad tooth is so often the cause of a pain described by the patient as localized in the ear. Secondly, swollen glands in the neck region may produce pains which the patient falsely refers to the ear on the side affected. Especially, however, do inflammations in or around the tonsils (peritonsillar abscess) produce pains which the patient describes with great certainty as being situated in the ear. These pains are increased by every act of swallowing, because muscles of the Eustachian tube are thus brought into action.

CHAPTER XVII

PAIN IN DISEASES OF THE NOSE[1]

The Sensory Nerves of the Nose.—The nose receives its sensibility from the first two branches of the trigeminus. The lateral wall receiving its sensory supply from the anterior and posterior ethmoidal nerves, which take their origin from the first branch of the trigeminus, while the infraorbital and sphenopalatine nerves, which come from the second branch, participate in the innervation of the other parts. The nervi septinarium, which are the sensory nerves of the septum, also have their origin in the second branch of the fifth nerve. Of the sinuses the frontal sinus and the anterior ethmoidal cells receive their nerve supply from the ophthalmic ramus (trigeminus I), while the posterior ethmoidal cells and the sphenoidal sinus are supplied by the nervi nasalis lateralis superiores and the nervi ethmoidales posteriores.

The exact relations, according to the description of Zuckerkandl, are the following: The nervus nasalis anterior passes through the foramen ethmoidale anticum toward the anterior cavity of the skull, where it extends to the edge of the cribriform plate toward the anterior portion, and is there covered by the hard sheath of the dura mater; then, after passing through the ethmoidal canal, it goes to the nasal cavity, where it divides into the ramus septinarium, the ramus lateralis, and the ramus anterior. The posterior nerves of the nose are derived from the sphenopalatine ganglion, and after passing through the foramen enter the nasal cavity, where they are distributed to the lateral and median wall. The nervus nasopalatinum scarpi, the true septum nerve, which originates from the same source, supplies the anterior mucous membrane of the palate after having passed through the canalis incisorus.

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[1] By Privat Docent Dr. Emil Glas, assistant in the University Clinic in Vienna (Director Hofrat Chiari).

Diseases Which Produce Pain and Their Manner of Production.—*Introitus narium, folliculitis, eczema introitus, and the specific inflammations* in the region of the anterior portions of the septum produce pains such as one finds in all inflammations, and need no special explanation. One should never forget, in acute pains arising suddenly in the region of the introitus, closely to inspect the anterior angle of the entrance of the nose, for in this place one often finds a hidden folliculitis, or a small retention of pus, which may easily produce severe pain. This is of special importance in case of erysipelas, which not infrequently begins at the introitus narium. It is well to mention the septum abscesses, which are always accompanied by severe pains, and are most frequently of traumatic origin. Pains in the region of the cartilaginous portion of the nasal septum, combined with a stenosis of traumatic origin, at the nasal entrance, point to the formation of a septum abscess. The pains may be caused either through inflammatory irritation of the terminal ramification of the septal nerves, through compression or degeneration, or through pressure from the suppurating hematoma. Long, persistent pains, after a discontinuation of suppuration, point to a fracture or to a spreading of the fissures of the skull.

Nasal Stenosis.—The various headaches that are caused by nasal stenosis deserve special consideration, for they are often accompanied by other phenomena, such as psychical depression, inattentiveness, loss of appetite, neurasthenic symptoms, and lack of concentration. These phenomena, which were mentioned by Piorry as symptoms of rhinostenoma, are caused by nasal polypi, large hypertrophies, higher grade septum deviations, and tumors of the nose, and can be cured by endonasal therapy.

Hartmann, in his work on "Nasal Headaches and Nasal Neurasthenia," has given the following explanation for headaches caused by nasal stenosis: If too little oxygen passes into the lungs through a partly stenosed nose, and consequently a diminution of exhaled air, as is physiologically necessary, occurs, the oxygen content of the blood is diminished and an accumulation of carbon dioxid takes place in the blood. It is not only the accumulation of carbon dioxid that is to be considered, but there are other by-products formed that are classed as toxins. Hartmann states that, through partaking of poor nutritive matter, a bad influence is produced upon the nervous organism, and that only in this way is the appearance of headaches and neurasthenic symptoms to be explained. Just as neurasthenic conditions appear in persons who are crowded into closed or poorly ventilated apartments, so, also, difficulties are called forth through lack of nasal breathing-space.

In children with ADENOID VEGETATIONS Lichtwitz and Labrayes have proven that the oxygen of the blood and the number of red blood-corpuscles are considerably reduced, while the white ones are increased; and that, upon removal of the adenoids, the number of red corpuscles and the oxygen constituents of the blood are heightened. This change, especially, should be considered by those who do not estimate highly enough the importance of adenoids, and who deny the disappearance of a number of reflex symptoms after the nasal pharynx has been freed of its encumbrances. The headaches produced by nasal stenosis can, in most cases, be cured through operative procedures. However, one must not forget that quite a number of internal diseases may also produce these cephalalgias, which fact should receive consideration in applying therapeutic measures (see Headache, Chapter XIV, page 262).

Empyema.—The *headaches* arising in empyemas of the sinuses are found in acute as well as in chronic empyemas, and each has a different genesis. Should it be possible that, at the same time with the inflammatory changes of the sinus mucous membrane, the terminal ramifications of the sensory nerve apparatus also suffer inflammatory changes; or should it be possible that distant influences might also be acting as causative factors (the latter being classified in the group of referred pains), only after exclusion of these factors is it proper to think of the neuralgic pains, which, arising in cases of empyema, can be traced back to a stasis of secretion and secondary pressure phenomena. The other neuralgic pains caused by nasal affections will be considered in regular order.

In his work on "The Significance of Rhinology for Internal Diagnosis and Therapy" Glas has especially called attention to and emphasized the fact that often the cause of these headaches is not discovered for a long time, and that all possible measures to relieve the sufferings may be utilized without result.

Other pains found in inflammatory states of the sinus are the *local pains* that occur in the cavities themselves, as aching, boring and piercing pains, and occasionally, as in cases of stasis, severe and throbbing pains. These pains, which are similar to sinus abscess pains, may also be produced by percussion of the external wall of the suspected sinus, or, if previously existing, may be increased. In this way in those sinuses whose walls are percussible (as the maxillary sinus, frontal sinus and anterior ethmoidal cells) one is able to decide, in some cases, even the extent of the diseased area, and the size of the diseased sinus. Occasionally, through the detection of percussion pains, one can determine whether there are abscess formations and septum deviations in the frontal sinus. These observations may be substantiated by X-ray examinations.

Finally, *pains arising in other parts of the body* may be genetically related to diseases of the nose, especially to empyema, as described by Flies in several cases. These phenomena belong to the large group of reflex neuroses of the nose. A careful study of these pain reflexes has also been made by Head, who finds that diseases of the olfactory (upper part of the nose) cause referred pain and superficial tenderness over the nasal and midorbital areas (q. v.): disease of the nasopharyngeal part of the respiratory tract may cause pain and tenderness in the nasolabial area. But, as a rule, the nasal affections do not cause pain. Since the pressure pains are of value for the localization of the diseased areas, the statement of the patient in regard to the location of the headache would be of special diagnostic importance, were it not for the fact that there are many cases in which the subjective sensations do not coincide with the objective findings. Similarly, one often finds that patients with a disease of the sphenoid sinus or posterior ethmoidal cells often refer the pains to the region of the anterior sinuses, which, upon examination, are found perfectly healthy, and vice versa; so that one cannot use pain localization as an absolute indicator in the topical diagnosis of diseased sinuses.

That *neuralgias* may be produced by suppuration of the sinuses has been proven by Peyre, who had a case of facial neuralgia, which had been complicated by the removal of the Gasserian ganglion, and which disappeared after a septum and maxillary sinus operation; or by Hartmann, who had a case of trigeminus neuralgia, accompanied by insomnia of several weeks' duration, which was completely cured after removing a caseous mass from the antrum. The writer is at present observing a case of intensive infraorbital neuralgia of several weeks' duration, which was treated galvanically without result, and which completely disappeared after Cowper's alveolar operation of the maxillary sinus. Also, cases of frontal sinus empyema, accompanied by supraorbital neuralgias, are not infrequently cured by operation.

Headache from Disease of the Sphenopalatine Ganglion.—The experiments of Greenfield Seüder, who believes that the sphenopalatine ganglion is an important factor in the production of headaches of nasal origin, are of much interest. He believes that, secondarily, the ganglion is sympathetically affected in intranasal inflammation, and applies his therapeutic measures accordingly. He has tried to anesthetize the ganglion by making cocain application behind the posterior end of the middle turbinate, and succeeded in several of his cases. At the same time he describes cases in which headaches have disappeared after cauterization of these areas, a fact which seems to point to an affection of the ganglion.

Obstructed Sinuses.—Here we may consider the observations which convince the writer, as well as Hartmann, that also in cases of nondiseased, but obstructed, sinuses, or in cases of poor communication between the sinuses and the nose, severe pains may exist, which, upon removal of the obstructions, are immediately decreased. I know of a colleague whose left maxillary sinus I must puncture four or five times a year, without being able to detect at any time any inflammatory affection of the antrum. However, I noticed at the first puncture that I made, on account of the severe, one-sided headache, that by the inflation of the antrum with air the characteristic antrum murmur was missing, and that it took more pressure than normal to inflate; therefore, I was forced to conclude that the ostium relations were unsatisfactory, and were either injured or had been insufficiently developed. Although there was no secretion to be found in the return solution after douching the antrum, nevertheless the colleague felt well after the rinsing. The headaches disappeared for some time, until the conditions demanded another puncture, which had to be repeated four or five times a year. The patient has not accepted my proposition to enlarge the communication and thus relieve him of his sufferings, although this operation might free him of his pains forever. Such cases indicate that the destruction of the communication, or a hindrance between the sinuses and the nose, can produce headaches even where there is no sinusitis present.

Hartmann has also made similar observations, and gives the following explanation to prove the truth of his assertion: (1) In those cases in which existing frontal headaches cause one to believe that there is a frontal sinus disease, the frontal sinus may be opened without finding any diseased condition. In such cases the pains may disappear after opening the frontal sinus, to reappear, however, when the external opening heals, unless in the meantime a communication has been made with the nose. If a communication has been made, the pains are absent as long as the communication exists.

(2) There are cases in which, after an operation on the frontal sinus, exacerbatory symptoms arise in the form of headaches without a real recrudescence of the disease, but only a closure of the opening into the nose, and it is this closure which produced the frontal headaches. In such case it suffices to open the

thin scar on the forehead with a sound. This allows the entrance of air, and thus relieves the headaches.

(3) The third deduction of Hartmann's is not absolutely unchallengeable, for in those cases in which an empyema had existed (about eight), and which were cured, the reason that the headaches disappeared after the formation of a communication between the nose and the frontal sinus can be traced, possibly, to a retention of secretion, and not to the exclusion of air in the sinus.

Tumors.- Headaches are, furthermore, a very important symptom, and are often the most prominent phenomena observed in the malignant tumors of the nose. Harmen and Glas have shown that the headache was the most important symptom in nine out of thirty-two cases observed.[1] These headaches, in spite of the better drainage of the pus, the result of an existing empyema, continued in the same degree after the removal of the growth. This showed that a deeper affection must have been the cause. The two following cases may prove the truth of this assertion: (1) Patient Z came, for dispensary treatment, with severe pains of the right cheek, accompanied by periodic, right-sided headaches. Rhinoscopical examination showed pus in the right nostril, especially in the middle meatus. Considerable pain was present upon pressure on the right maxillary sinus wall. The probable diagnosis made at the time was empyema of the antrum. Puncture of the right maxillary sinus was positive. Since the suppuration was not lessened by repeated douching through the ostium, the maxillary sinus was opened, through the alveolar process. Repeated douching was given. Nevertheless, the pain did not cease. The continuation of the pains, in spite of the opening and the douching of the antrum, indicated that another process must be present besides that of empyema. The histological examination of the resected lower turbinate showed cylindrical-celled carcinoma.

(2) A woman, fifty years of age, had a polypus removed from the right nostril a year previous to her admittance. Eight months later, on account of profuse suppuration, the maxillary

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[1] Deutsche Festschrift für Chirurgie.

sinus was opened through the alveolus. In this case there were two factors which indicated the probability of a malignant formation of new tissue, namely, the intense pain and the fetid condition of the returning fluid of the douching solution. The histological examination of an excised mass then gave the diagnosis of stratified epithelioma.

The cause of the headaches in malignant tumors of the nose may be various. The origin may be one of the following: (1) reflex irritability, (2) blood and lymph stasis, (3) nerve pressure, (4) meningeal irritation, (5) the result of an empyema occurring at the same time.

Zuckerkandl shows, in his anatomy of the nose, the superficial position of the ethmoidal nerve in the anterior portion of the skull, and adds that this exposed position allows approximating swellings to cause pressure symptoms. That headaches sometimes arise as localized symptoms is shown in the second case, cited by Harmen and Glas in their article on "Malignant Tumors," in which right-sided, frontal headaches existed. Autopsy showed penetration of the roof of the orbit and a growth of the tumor into the right frontal sinus. We deduce, therefore, that, after cleansing of the sinuses, constant pains should call forth the suspicion of malignant neoplasms. In one of my last cases, on autopsy, I found a meningeal hyperemia, which may have been the cause of the violent and increasing cephalalgia during the last days of the patient's life.

Finally, we cannot deny that those swollen areas in the interior of the mucous membrane, found on section, may, by compressing certain structures, very frequently be the cause of severe, continuous headaches.

DIAGNOSIS

In cases of acute empyema the pains are sometimes very violent, and one cannot be reminded too often of the fact that, when pains arise during a coryza, or an influenza, a thorough rhinological examination should be made. The result of therapeutic measures in empyema is often marvelous. A puncture through the inferior meatus, or a douching through the natural opening in sinusitis maxillaris, or the application of cocain on the anterior end of the middle turbinate, in frontal-sinus affections, can relieve the most acute pain. Unfortunately, even at the present time, one finds many cases which are treated for weeks, either galvanically, or faradically, are massaged, or receive other resultless treatment, without the attending physicians even surmising that the sinus is diseased.

A test of importance, which I have introduced into rhinology, may frequently be applied. The principle of this test is the following: The tuning fork, which is held anteriorly in the median line above the bridge of the nose, is lateralized to the side where the diseased sinus exists. In case the ear is not affected the patient hears the tuning fork only on the side, or more intensely on the side in which the sinus is affected.

This method, which was tested in several hundred cases, affords important service to one who is not thoroughly conversant with exact rhinological technic, as he is able to state, in cases of neuralgic headaches, whether they can be traced back to affections of the sinuses. I have seen cases in which patients complaining of severe neuralgias were sent to a rhinological specialist for examination, in whom Glas's tuning-fork test proved to be negative (i. e., the tuning-fork was heard only at the point of application, or, as the patients said, heard alike at all parts of the head), and in whom, as a result of complete rhinological examination, empyema could be excluded as the cause of the neuralgic pains. On the other hand, this test affords the rhinologist important service in a diagnostic and prognostic manner, in regard to which Glas gave more explanatory details at the International Rhino-Laryngological Convention in Berlin, 1911.

At the same time one must not forget those cases in which there is no stenosis, but in which hypertrophy of the middle turbinate is the determining factor of the headaches, which disappear after resection of this part. These headaches are classed by some as symptoms of stenosis, but by others they are placed in the group of Flies' reflex symptoms. At any rate the pressure of the turbinates on the septi may cause reflex pains. The explanation of Casali, however, is more reasonable. He assumes the cause to be compression of the vessels of the nasal mucous membrane, which are in communication with the veins of the dura mater and the superior longitudinal sinus, the blood and lymph stasis of the mucous membrane of the nose causing a stasis in the dura covering the brain. There is no doubt that, in such cases, the result of resection of the hypertrophy of the turbinate is striking. On negative internal findings, the diagnostic significance of this therapy should not be forgotten. Here may be included those cases in which severe neuralgias are relieved by endonasal operations. In regard to this point, I have expressed myself in my work on "The Significance of Rhinology for Internal Diagnosis and Therapy," in the following manner: Any one who has had occasion to cure a severe neuralgia by an endonasal operation will know how to emphasize the importance, indeed the utmost necessity, of a rhinological examination in every case of neuralgia of the fifth nerve. The following cases may illustrate the foregoing statement:

(1) In the case of a patient who had suffered for years with a neuralgia of the infraorbital nerve, I found, by rhinological examination, a rhinolith lying under the middle turbinate and pressing upon the processus uncinatus. On its removal the neuralgia disappeared.

(2) A patient who had tried various therapeutic treatments for a trigeminal neuralgia, in his despair consulted a rhinologist. By chiseling a broad crista of the septum, which extended in an especially sharp angle to the middle turbinate, relief of the neuralgia was at once obtained. A single example of this kind is of more value than a multitude of reflections, and proves the utmost necessity of a rhinological examination of such cases.

In conclusion, it may be added that sometimes, after a radical operation on the frontal sinus, neuralgias of the supraorbital nerve arise. Therefore, it seems rational that, while doing the Killian operation, one should remember this fact, and resect the supraorbital nerve.

CHAPTER XVIII

PAIN IN DISEASES OF THE THROAT

PAIN IN DISEASES OF THE PHARYNX[1]

The sensory nerve of the pharynx is the lingual. From it are derived the sensory receptors of the anterior palatine arch, the tonsils, the floor of the mouth, and the tongue. This and the glosso-pharyngeal divide the supply of these parts, while the region of the gingiva is supplied by the alveolaris inferior.

Pain in Acute Diseases. All the inflammatory processes in the region of the pharynx contribute toward pain production, for instance, the different forms of angina, the inflammation of the pharyngeal tonsil, retropharyngeal abscess, and herpes, febrile and zoster form. In this group of diseases phlegmonous angina, retropharyngeal abscess, and diphtheritic inflammation are especially prominent.

Phlegmonous angina often produces very severe pain, which is increased by every movement of the mouth, and which has radiations in the ear which are often unbearable. These are sometimes produced through a pus area developing in the deeper tissues, sometimes through an inflammatory edema of the surroundings. The pains are sometimes boring, sticking, excessive, or trivial. The localization of the pain is frequently inexact. When it is located in the nasopharynx, in the ear, or in the region of the ostium tubæ, the increased pain upon pressure outside on the anterior mandibular muscles is characteristic.

Upon opening a *peritonsillar abscess*, the making of the incision in the right place, that is, at the point where the pus comes nearest to the surface, is of the utmost importance, since the incision and dilatation of the point of incision in an edematous but not pus infiltrated area occasion very severe pains, which frequently cause fainting. On the contrary, the incision in the infiltrated area is relatively painless, and causes an instantaneous improvement.

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[1] By Privat Docent Dr. Emil Glas, of Vienna University.

Retropharyngeal abscess often produces pain similar to that of phlegmonous angina, save that in the former the location corresponds to the deeper seat of the affection, which lies further back and lower down. Deglutition also occasionally is difficult and is associated with severe pain, which is increased by the swelling of the corresponding glands of the neck. The acute process, as a rule, does not affect the vertebra, but chronic retropharyngeal abscess may cause necrotic processes in the vertebral column. Concussion of the vertebral column, produced from above, causes no increase of the pain in the acute form.

In *diphtheria* swallowing pains are usually severe. Frequently, from the swelling of the velum, the taking of food becomes difficult and painful, although in many cases no trouble of any sort is present. Generally there occurs a painful swelling of the submaxillary glands; likewise, of the lymph glands lying under the sternomastoid muscle; these frequently grow into a large, very painful lump, especially sensitive to the touch. Here, one must not forget, in pharyngeal diphtheria, the pains arising (through the general infection) in the head, neck, back and the region of the buttocks, which often cause the patient very much trouble.

The *acute infectious diseases*, especially influenza, which causes very severe neck pain, with but little objective findings, are of interest. Escat has described such cases and has diagnosed them as pharyngodynia from influenza. Here one finds, at the most, a slight degree of erythema. This painful angina is closely related to the herpetic angina and disappears in the course of a few days.

The *febrile herpes of the pharynx*, which is often associated with laryngeal herpes, appears very frequently in groups, occurring, also, in the form of small, diffuse, epidermic vesicles, and is especially characterized by pain on swallowing. In a work given out from the Chiari Clinic of the Vienna University, Glas mentioned that frequently, after a short prodromal stage, severe difficulties of swallowing and sticking pains occurred in the throat, accompanied frequently by hoarseness and difficulties of breathing. The dysphagia often reaches such a pronounced degree that the patient is unable to take nourishment. Examination of the mesopharynx very frequently gives an entirely normal picture. Laryngoscopic examination first shows on the base of the tongue, in the region of the follicular papillæ, on the vault of the pharynx or on the pharyngeal wall, symmetrical vesicles. These are very prominent, varying in size from a poppy seed to a lentil, and are filled with white contents lying on a red base. These vesicles may be scattered, without any arrangement, or they may be gathered into groups. At this point it is time to emphasize (as we shall do later, in our description of chronic affections) the fact that one should always, in cases of pain on swallowing, examine the region of the hypopharynx, where these efflorescences are likely to occur.

As an example of these interesting infections, in which severe pain is always present, the following case is of note:

"The patient, fifty years of age, felt, for a few days, weak and tired; three days previous, chills and high-grade dysphagia. The patient gave the impression of being very ill, the head being held as it is in peritonitis gravis. The temperature was 38.9° C. (102.2° F.) and the pulse frequency was 110. The pharynx was perfectly free, and the tonsils were not in the least inflamed. The opening of the larynx (aditus) was greatly changed; the epiglottis, the aryepiglottic folds, the valliculæ in the recessus pyriformis, were covered with vesicles of a somewhat similar size, not very prominent, and filled with gold-colored contents."

Herpes zoster may, as I have frequently seen, give rise to very special pain in the region of the pharynx, which assumes a neuralgic character and reaches such an intensity that the otherwise fairly resistant patient whines and complains. Kaposi has described cases which correspond with the distribution of the maxillary nerve, the pains at the same time occurring in the cheeks, the palate and the pharyngeal mucous membrane of the affected area. The herpes arises sometimes as a diffuse, painful redness, sometimes as a group of efflorescences of a short duration, or even as gangrene of the rami palatini and pharyngei. Frequently with the significant difficulties of swallowing severe toothache is present, with the resulting continuous neuralgiform pains. I have seen two cases of herpes zoster associated with high grade dysphagia. In these cases only the mucous membrane of the mouth and pharynx was affected, and the efflorescence was interrupted sharply in the median line. Cases have also been described in which it is almost impossible either to speak or to chew, each movement calling forth a *tic douloureux*.

Herpes zoster is occasionally mistaken for *acute pharyngeal affections*. Here, also, phlegmonous inflammation of the base of the tongue is to be considered, for it very often occasions unbearable pain, and, like peritonsillitis, makes deglutition impossible. The pains, which are severe, sometimes radiate to the ear. These diseases, because of the action of the inflammatory exudate on the glosso-pharyngeus, give rise to stimuli which are conducted back through the vagi, and are often associated with profuse salivation, high-grade prostration, and difficulty of breathing.

Pain in Chronic Diseases.—Among chronic diseases of the pharynx, which cause interesting pains, tuberculosis, lues, and malignant neoplasms of this region are prominent.

Tuberculous ulcers of the pharynx produce severe pain, which is increased in swallowing. The pain frequently radiates to the ear, and the deeper the process extends the more severe it becomes. The maximum is reached in tuberculous affections of the aditus laryngis, a very frequent disease. The ulcers located in the epipharynx, especially those having their location near the tuba of the ostium of the pharynx, are very painful, and, because of their location, are noteworthy, since for their diagnosis an exact posterior rhinoscopy is necessary (the unskilled rhinoscopist, in order not to overlook these diseased parts, should use a pharyngoscope).

Swallowing, in cases of *pharyngeal tuberculosis*, is often very painful, and causes vomiting, which, in turn, aggravates the pain. Very frequently otherwise active anodynes, such as cocain, morphin, orthoform, etc., are entirely without effect, and the physician finds it necessary to resort to morphin injections. For the severest laryngeal pain the alcohol anesthesia of the nerves is especially to be recommended.

Luetic ulcers, at first, are not associated with very great pain, the superficial mucous membrane plaques causing only slight trouble; and attention should be called to the disparity between the extensive process and the slight trouble as characteristic of the first stage of syphilis. The first pain occurs on the deep extension of the process, and may (for example, in deep, ulcerating gummata) reach a very high degree. Gummata of the base of the tongue and of the epipharynx, lying principally on the roof of the pharynx, may exist, in which the most prominent symptom is the excessive pain. Diffuse pain, radiating chiefly into the ear, accompanies this stage of the syphilitic process. It is also to be emphasized here that, with this group of symptoms, an exact retronasal examination should be made, and the region of the circumvallate papillæ carefully examined, because it is exactly here that the concealed seat of the affection is often to be found.

In *carcinoma of the base of the tongue* there may be no pain in the early stages. The patient experiences only a scratching or a tickling in the neck. Often, upon pronounced movement of the tongue, he has the sensation as of a foreign body in the pharynx, and his complaint of this may lead to a false diagnosis. The deep extension of the carcinoma first produces severe, often significant pains radiating into the ear, the jaw, or the larynx. Professor von Bergman held the hemorrhage and pain which are produced through the movement of the tongue, and through the contact of the hard food, as characteristic features of carcinoma of the tongue. He says: "They frequently are as pronounced as in the flat, tuberculous ulcers on the margin of the tongue. Frequently they are neuralgic in character, and radiate toward the ear, and the unhappy patients often complain fearfully" ("Handbook of Surgery").

Of the group of chronic infections with which severe pain is associated *pemphigi of the mucosa* are conspicuous. Often they suddenly burst open, or the vanishing vesicle, through hemorrhage of the submucosa, may occasion an increase of the pain, especially in the efflorescence of the mucous membrane lying adjacent to the pemphigus follicle, which causes a diffuse epithelial desquamation, produces a high degree of dysphagia, and, as a result of inanition, quickly incapacitates the patient.

The NEURALGIAS OF THE PHARYNX, which, without demonstrable organic changes, are found in hysterical individuals, are also to be considered. The patient often, for hours, will complain of lightning pains arising in the different parts of the mouth and radiating into the pharynx. Here, one should always seek for the pressure points, which are located in the region of the laryngeus superior glosso-pharyngeus or the lingualis. Those affections arising through tonic contraction of the swallowing muscles may be designated as hysterical dysphagia. In these strong pressure, accompanied by the closing of the teeth, produces a sticking or tearing pain.

PAIN IN THE LARYNX

The sensory component of the vagus is the superior laryngeal nerve, which, arising from the vagus, runs median to the internal carotid as far as the thyrohyoid ligament. At the upper half of the greater cornu of the hyoid bone the nerve divides into an outer and an inner branch, of which the outer has motor and the inner sensory fibers. The latter passes through the thyrohyoid ligament and reaches the recessus pyriformis, where it supplies the mucous membrane covering the plica of the laryngeal nerve, and ends in the mucous membrane of the larynx. At the same time it forms an anastomosis with the laryngeus inferior, and concerns itself with the delivery of sensory nerve fibers to the recurrens. At this point, the observation made by Massei, of anesthesia of the laryngeal entrance in recurrens paralysis, may be cited. This he gives as a reason for his opinion that the recurrens really conducts sensory fibers. My examinations, following those of Massei, do not confirm his observation, so that I, as the result of an enormous amount of clinical experience, and because of other reasons, have reached the conclusion that the recurrens has nothing whatever to do with the sensibility of the larynx.

Referred Pain.—Diseases of the larynx generally produce no referred pain nor tenderness, but when pain does exist, it is generally felt in either the superior or inferior laryngeal area, the upper area being particularly associated with disease of the epiglottis and aryteno-epiglottidean folds, the lower area being particularly associated with disease of the cords (Head).

Pain in Acute Affections. Laryngeal pain may be found in all acute inflammations, chiefly in those associated with pus formation. Here the intensity of the pain depends especially upon the location of the process. The aditus laryngis, that is, the epiglottis, aryepiglottidean folds in the arytone, is the region in which inflammation produces the most severe pain. It depends, on the one hand, upon the richness of the sensory nerves in this region, and, on the other hand, upon its relation to the process of swallowing. The bolus, gliding over the aditus, irritates the inflamed area and produces, at the same time, an increased reaction as well as pressure pain. A clear proof of the increased pain sensibility in involvement of the aditus is found in acute affections; for example, in herpes laryngis, involvements of the aryepiglottidean folds and the recurrens pyriformis are so painful that swallowing becomes impossible. Here the pain frequently radiates into the region of the base of the tongue and the middle auricular nerve of the vagus in the ear zone. On the side of the larynx a clearly defined ulcer may frequently be present for a long time without causing severe pain, because swallowing is not disturbed. Here, upon manifestations of pain in these parts, I again suggest a minute examination of the entrance of the larynx, especially of the recessus pyriformis, in order to avoid the overlooking of a diseased process.

Chronic Processes.—Under the chronic processes are, again, the *tuberculous ulcers*, as well as the crumbling carcinoma (extralaryngeal), which may give rise to an intense, often unbearable, pain. The dysphagia of a patient suffering from a diffuse laryngeal tuberculosis often reaches such a high degree that he will refuse to take food. The blowing in of orthoform, the instillation of menthol, the insufflation of morphin, dysphagia tablets, painting with cocain, etc., very frequently fail, in the ulcerative form of laryngeal tuberculosis, to relieve the pain, so that in a short time after the onset of this affection one can do nothing for the conditions.

The anesthesia of the entrance to the larynx, by Hoffman, through injection of alcohol in the superior laryngeal nerve, at its place of entrance through the thyrohyoid ligament, has given a very satisfactory result in many cases, in that the dysphagia diminishes and the otherwise rapid inanition is hindered. I can, upon the basis of a large number of injections made in very sick tuberculous patients, warmly recommend this treatment, and I would like to emphasize the fact that, in a number of cases, I was able to induce an anesthesia persisting through many weeks.

The pain in *carcinoma of the larynx* depends upon the localization of the tumor. Extralaryngeal tumors, lying in the region of the aditus, give rise very early to pain on swallowing, while in intralaryngeal tumors pain may not appear for a long time. There are, then, because of the overgrowth of the tumor, severe disturbances of swallowing. One may say, in regard to the early diagnosis of carcinoma of the larynx, that the first symptom of the extralaryngeal carcinoma is, as a rule, dysphagia and that the first symptom of intralaryngeal carcinoma is hoarseness. Yet there are cases, to which Leopold von Schroetter, especially, has drawn attention, where, in spite of severe destruction in the region of the aditus, pains are entirely absent. However, these are very rare. The explanation lies in the fact that in these cases there are sensory disturbances in the area of distribution of the superior laryngeal nerve. Generally the pains are spontaneous, on deglutition as well as upon external pressure. The pain in carcinoma of the larynx is explained through the simultaneous occurrence of inflammatory conditions, necrosis formation, and hardening, while the pressure symptoms, or the propagation of the irritability, occur from the involvement of the superior laryngeal nerve. Often the pains assume the form of neuralgia, and radiate as lightning pains into the region of the nervus auricularis vagi.

LARYNGEAL NEURALGIA is infrequent, and is observed in hysterical and neurasthenic subjects. The neuralgia often radiates to the ear and frequently reaches an unbearable severity. Lemon has reported a case in which a patient, in the climacteric period, threatened suicide if freedom from her raging pain was not obtained for her. In other patients, when the pain occurs on speaking, it shows itself as a typical phonophobia. Finally, it is mentioned that, in these glottis spasms which we so frequently find in tabes dorsalis, the so-called laryngeal crises, hyperesthesia and hyperalgesia, in the form of sensory auræ, are often found, and introduce the cramp crises. The explanation of these forms of pain is probably analogous to that of the adduction spasm, they being due to an irritation of the sensory sphere. The typical attack in such cases occurs as a peculiar sensation in the larynx, in the form of a sticking, burning, lightning pain, accompanied by states of anxiety or feelings of suffocation, after which the spasm of the glottis follows.

CHAPTER XIX

ABDOMINAL PAIN

Classification. There are two classes of abdominal pain: subjective and objective.

The subjective pains belong to the class of symptoms usually termed hysterical. For their production no organic basis can be found. They seem to be due to the awakening into consciousness of sensation-phenomena stored away in the subconscious mind.

Objective pains, on the other hand, have for their production either some definite pathologic change, functional or organic, or a changed relationship of the organs as a whole to other adjacent organs, such as occurs, for example, in a ptosis of the stomach or of the liver.

Subjective pain, in relation to the abdominal viscera, will not be considered here. It has already been discussed in the opening chapters.

Objective abdominal pain is important because of its relationship to changed pathology in the abdomen. It may be due to a lesion of the skin, the subcutaneous tissues, the muscle, the peritoneum, or the viscera.

The SKIN is frequently painful, especially when it is the seat of some inflammatory skin-disease, such as erysipelas. It is also very painful in certain nerve lesions, as neuritis, or herpes.

The MUSCULAR LAYER OF THE ABDOMINAL WALL is credited by Mackenzie with pain production. He says: "It is the muscular layer in the abdominal wall which is so exquisitely tender in all affections of the viscera, giving rise to severe reflex musculovisceral pain, as in appendicitis. Also, the abdominal muscles above the lesion are in a state of contraction and are extremely tender to pressure." That Mackenzie erred and exaggerated the importance of the muscular coat in pain production is proved by the researches of Lennander and others. Later, Mackenzie (862) himself, modifying his previous statements, says that the subperitoneal layer is the most sensitive, and, in confirmation of his views, quotes Ranstrom, who has found many nerves and nerve endings in this layer. The nerves are derived from those supplying the muscular layer. All direct painful muscular lesions in the abdominal wall are the result of inflammation, neuritis, neuralgia, myalgia, or new growths.

Inflammation in the abdominal wall is accompanied by all the signs and symptoms usually associated with inflammation in general, such as swelling, redness, heat and loss of function. The pain is of a throbbing character. Tenderness on pressure is also present. In some cases the inflammation precedes abscess formation. Such cases are described by Hitzrot (337). The pain was localized, and was increased on assuming the erect posture and on deep pressure. He quotes Fouquet (370), Sonnenberg (371), Spellisy (372), Heller (373) and Allison (374), who have all described similar conditions.

Neuralgia of the nerves of the abdominal wall occurs and is frequently observed with or after infectious diseases. When it is present the skin is exquisitely tender, and is very painful to the pressure made by pinching it between the fingers. In this it differs from peritonitis, in which the skin is not so tender, and the pain is produced only on deep pressure. In neuritic lesions of the abdominal walls the pain is usually unilateral. When the lumbar nerves are affected, the pain is commonly felt in the hypogastric region, a little to one side of the median line. In this area, too, there is localized tenderness on pressure. Tender spots are also found, one a little to the outside of the first or second lumbar vertebra, and another immediately above the crest of the ilium. In women, who are by far the greatest sufferers from this disease, there is also sometimes, about the middle of the Fallopian tube, a spot, pressure upon which causes pain to be referred to the anterior abdominal wall. There is another spot above the uterus. In men, points here and there on the scrotum are found which are painful to the touch. These points of tenderness serve as characteristic signs of neuralgia. Neuralgia is to be diagnosed, not only from colic, but from lumbago and rheumatism of the abdominal walls. Diagnostic signs of neuralgia are the absence of fever and the relief which is produced by pressure and ordinary antineuralgic remedies.

Neuritis of the intercostal nerves is fairly frequent. This frequency occurs because these nerves are particularly subject to the deleterious influences of cold and traumatism, on account of their exposed position. (For a more complete description see under Neuritis.)

Myalgia is closely related, as far as etiology is concerned, to the neuralgias. It seems to be due in very many cases to a disordered metabolism. This is the condition to which the term "rheumatism of the abdominal wall" is given wrongly.

New growths, such as cysts and various kinds of tumors, may occur in the abdominal wall. If of slow development, they cause no great inconvenience, for by their slow increase in size they gradually push the surrounding structures to one side, and the tissues learn to accommodate themselves to the presence of the foreign occupant. Should nerves be incorporated in the growth, and pressure be exerted upon them, pain, generally of an aching character, results. This pain may be localized to the region of the growth, or may be referred to some distance in an area to which the affected nerve is distributed. The size of the growth bears no relationship to the amount of pain which it may produce, the smaller growths producing as much, if not more, pain than many of the larger ones. The amount of the pain depends upon the rapidity of the growth, the number of nerves incorporated in it, and the pressure exerted upon them by the inclosing tissues.

PERITONEUM.—According to Mackenzie, the peritoneum of itself is devoid of pain nerves. However, he claims that the subperitoneal layer is plentifully supplied with pain nerves, and that it is here that the painful impulses arise. In its lack of pain perception, the peritoneum, he says, is not unique among serous membranes, for this is characteristic, he holds, of all serous membranes, since they have no nerves which will transmit pain stimuli of the kind found in the skin, the tunica vaginalis testis being the only serous membrane which is sensitive to the usual tests for pain sensibility. This is due to the fact that the tunica vaginalis testis is innervated by a cerebrospinal nerve, the genital branch of the genitocrural nerve.

Mackenzie's proofs that serous membranes are not the seat of pain production were: (1) that the abdominal wall is very tender in certain visceral colics in which there is no inflammation of the peritoneum; (2) the skin of the abdominal wall generally is not so sensitive in visceral lesions, for it can be pinched between the fingers without producing pain; but if the muscles are grasped between the thumb and fingers, acute pain is felt; (3) direct stimulation of exposed pleura, pericardium, and peritoneum does not produce pain. That this is not absolutely true will be shown in the discussion of peritonitis.

The peritoneum is the lining membrane of the abdominal cavity. It consists of two layers: (1) the visceral layer, which covers the inclosed organs, and (2) the parietal, which lines the external wall of the cavity. It has been held by many that the visceral peritoneum is without pain sensibility, but, as will be pointed out, much depends upon the type of stimulus. The adequate stimulus in the viscera is deep pressure; that largely produced by tension. It is the type of deep sensibility described by Head.

It was the belief of Lennander that "all painful sensations within the abdominal cavity are transmitted only by means of the parietal peritoneum and its subserous layer, both of which are richly supplied with cerebrospinal nerves around the whole of the abdominal cavity, with the exception of a small area in front of the vertebral column lying below the crura of the diaphragm, and between the two chains of sympathetic nerves." Here he found no cerebrospinal nerves, but only nerves running more or less transversely between the two sympathetic chains.

He found that within this area the patient does not respond to hard pressure with a finger, or with an instrument, and that stretching of the mesenteric attachments at this point is not painful. So far complete uniformity does not exist as to presence or absence of pain sensibility in the peritoneum, though many observers are in accord with the deductions of Lennander.

Diseases of the peritoneum producing pain are inflammations, hemorrhage, and new growths.

Inflammations of the Peritoneum. Inflammation of the peritoneum (peritonitis) causes pain only when *acute*. The chronic inflammatory forms, as a rule, produce but little pain, except as the result of adhesion formation. The seat of the pain in peritonitis, according to Mackenzie,[1] is not in the peritoneum itself, but in the subperitoneal tissue. This layer is exquisitely tender, and Ramstrom found it richly supplied with nerve fibers, which, in turn, are derived from the nerves of the anterior abdominal wall. These nerves also supply the abdominal muscles, and thus one can account directly for the reflex rigidity of these muscles (supplied by the same nerves) when the peritoneum is affected.

In some cases, however, acute peritonitis may be present without producing any pain phenomena. This is especially so in the violent cases in which the abdomen contains a quantity of pus (Bradford, 207). This lack of pain may be due to the rapid destruction of the nerve endings, or to the impairment of their efficiency. Such a state is frequently met with in puerperal sepsis.

However, in all cases of sudden, sharp, exacerbating pain, with rigidity of the abdominal muscles, generalized tenderness, normal or subnormal temperature, and a rapid, rising pulse, peritonitis should be thoughtfully considered (Richardson, 23). Should the pain be dull and aching, the sub-peritoneal connective tissue is probably involved.

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[1] It is also claimed by Mackenzie that the parietal peritoneum of itself is insensitive to pain; that it is the tiny nerve filaments, distributed in the cellular tissue subjacent to the peritoneum, which are extremely sensitive, and that the slightest traction or pressure on them produces the most excruciating pain.

TUBERCULOUS PERITONITIS.—In cases of tuberculous origin pain may be an almost negligible symptom. The exceptions are those conditions in which adhesions have developed, or in which the tuberculous material has become encysted and has ulcerated or suppurated. This gives rise only to a little pain on walking, while obliterative, encysted, or sciatic forms may cause no pain (Rolleston, 619). In case of tuberculous peritonitis Bainbridge has found that the injection of oxygen into the peritoneal cavity will relieve the pain. This may be due to the separation of the two adjacent surfaces from each other, possibly to an anesthetic action of the oxygen.

A common source of mistakes in the diagnosis of peritonitis is the confusion of referred pain with that due to peritonitis. Diagnostic criteria between the two conditions are: (1) The tenderness of referred pain is produced by slight stimulation of the skin and the subcutaneous tissues, and seems to be relieved by deep pressure; (2) the exact opposite is found to be the case in peritonitis, deep pressure being painful, while light pressure is not so distasteful; according to Lennander (618), the boundaries of the hyperesthetic zones in peritonitis can be mapped out almost to a centimeter; (3) in peritonitis proper there is generally no referred pain; this is given by Moullin (226) as a good indication that no other viscera are involved, for as soon as the viscera become involved hyperalgesia is present; (4) in peritonitis the abdominal reflexes are not exaggerated, while in referred pain they are exaggerated.

Should a peritonitis be sudden in onset, as is the case in the perforation of an ulcer of the stomach, or of the duodenum, the pain is generally paroxysmal and is most severe. When the cardiac end of the stomach is involved, the pain, as a rule, is under the left scapula. When the pyloric end is the part affected, the pain is under the right scapula (Mayo Robson, 619).

If the abdominal pain is associated with tenderness it is necessary to distinguish between inflammation of the constituents of the wall (skin, muscle, peritoneum), neuralgia and neuritis. In peritonitis pain is produced only on the making of pressure on the abdominal wall, while in neuralgia or myalgia it may be necessary to pinch the skin or muscle between the fingers before pain is elicited. If peritonitis is present there is also pain on the patient taking a deep breath, upon the making of a pelvic examination, and also, in some cases, upon flexion of the body. Should the pelvic peritoneum be inflamed, pain is produced when the inflamed peritoneum is pressed upon by the examining finger. Tilting up of the uterus by pressure on the cervix will always cause pain, and pain is also present on making deep, and, if the peritonitis is severe, light pressure low down on the abdominal wall. Bimanual externovaginal examination will cause pain if the peritoneum at the brim of the pelvis is inflamed. Defecation, micturition and sexual connection (if a female) are also painful. The visceral peritoneum is different from the parietal peritoneum in that pain is not produced by pressure upon it; but it is very sensitive to traction made upon it through the mesentery. The pain produced by this traction is interpreted as coming from some zone of the body and not from the affected viscera. This Mackenzie explained by the fact that the abdominal viscera are supplied entirely by the sympathetic system, which has no sensory nerves. When it is irritated its nerves carry impulses to the cord cells and stimulate, in turn, adjacent sensory cells to activity, thus causing a painful impulse to be conveyed to the brain. This impulse is projected as if coming from the peripheral distribution areas of the sensory nerves, whose cells are stimulated.

CHRONIC peritonitis is somewhat different from the acute, and is much slower in onset and duration. The pain is due to the following causes:

(1) Traction and pull from adhesions, the result of the chronic inflammatory process.

(2) Distention of the bowel from gas or fecal matter, owing to obstruction of the lumen by adhesions which may be old or recent.

(3) Localized collections of fluid encysted by the peritoneal adhesions. These localized collections may be either serum, pus, or blood. After the fluid contents have reached a certain stage,

they begin to exert pressure or traction on the adjacent structures, and thus cause the pain. In some cases of slow, insidious peritonitis, especially those of tuberculous origin, there may be no pain of any moment until adhesions form, when pressure causes tension pains.

The location of the pain may give an indication of the viscera which are involved by the adhesions (for the points of reference on the abdominal wall of visceral pain, see Viscera, Chapter XX, pp. 383-389).

Hemorrhage.—In sudden, severe hemorrhage into the abdominal cavity, such as occurs in the rupture of an extrauterine pregnancy, pain is present; but in hemorrhages following operation, pain, as a rule, is absent. This latter condition can probably be accounted for by the previous insult to the peritoneum by the operative procedures, with the consequent reduction in its sensibility.

In some cases of excessive dilatation of the abdomen from tympanites, or from obstruction, the abdominal tenderness is excessive, but at the same time the pulse and temperature are not of a peritoneal character.

Tumors of the Peritoneum.—Tumors of the peritoneum generally cause pain. When they are in the back, and lie posterior to the peritoneum, they frequently cause pain by the pressure which they exert upon the spinal nerves. This pain is referred to the back or along the course of the nerves of the lumbosacral plexus. It must be diagnosed from the pains due to aneurysm, vertebral caries, or spinal tumor.

Nature of Pain from Adhesions.—As an end result of nearly all processes, both inflammatory and otherwise, in the abdominal cavity, is adhesion formation. These adhesions, as a rule, cause pain, which is generally localized to one spot, at which point pain is also produced by pressure.

The pain may come in paroxysms; when it does so, the attacks resemble each other, and have the same train of symptoms. The pain also is influenced by certain muscular movements or positions of the body, and may be lessened or increased by moving about or by turning over from one side to the other. It is increased by peristalsis, especially if the adhesions are between the stomach or intestine and the anterior abdominal wall. When the adhesions are between the stomach and the anterior abdominal wall, the pain is often increased after eating. Adhesion pain is also increased by tension of the anterior abdominal wall, when, by a backward motion of the upper part of the body, or hyperextension of the thigh, the distance between the ribs and the pelvic bones becomes increased. In such cases the recti muscles become rigid and traction is made on the adhesions. The magnitude of the pain varies indirectly as the area of the adhesion. This is due to the fact that, in extensive adhesions, the traction upon the parietal peritoneum is not limited to any one spot, as it is in very limited adhesions, but is spread out over a large area, and consequently, not being perceived acutely in any single nerve distribution, is felt rather as a dull, dragging pain, instead of a sharp, pulling one.

Increased tension of the anterior abdominal wall also causes pain in cases of hernia wherein stretching of the omentum is probably present.

Adhesions pulling upon the peritoneum, as a rule, cause greater pain if there is a sudden variation in the traction, such as can occur when a hollow viscus of changing size and position, such as the stomach, is attached to the anterior abdominal wall. In this case the pain depends upon the variations in the force of the traction, depending upon the amount of the stomach contents and the state of its functional activity.

Adhesions of the omentum and the anterior abdominal wall are a frequent cause of pain, because the bowel places the omentum on the stretch, by forcing itself into the pocket between it and the anterior abdominal wall. Adhesions between the viscera if not connected with the anterior abdominal wall cause no pain unless traction or pressure is made upon the mesentery or other pain sensitive organs, by the changing relationships or the hindered movements of the adherent viscera.

In this connection it might be well to consider the causes of abdominal adhesions. They are the following: (1) tumors, which form adhesions because of the pressure on, and consequent traumatism of, adjacent organs; (2) intestinal ulceration, which is not an active cause of adhesion formation unless perforation has occurred; (3) after laparotomies adhesion between the omentum and parietal peritoneum; and (4) inflammation, particularly that due to or associated with tuberculosis. Inflammatory lesions of the gall-bladder are also potent causes of abdominal adhesion formation.

Abdominal adhesions, according to Cunston, are divided into: (1) A gastric group, including cholelithiasis; ulcer of the stomach and duodenum; traumatism to the stomach, liver, pancreas, and duodenum; carcinoma of any of the above-mentioned organs; (2) the intestinal group, which is particularly associated with the appendix and the sigmoid; (3) the pelvic group, which includes lesions of the tubes, ovaries, and the uterus; and (4) the peritoneal group, including all lesions in which primarily the peritoneum is involved, as in tuberculous peritonitis.

Gastric Adhesions.—The diagnosis of adhesions may be made easier if it is borne in mind that when adhesion of a viscus to the anterior abdominal wall or to another organ occurs, pressure or traction on the abdominal wall, so made that it will tend to separate the two adhering surfaces, will produce considerable pain. Thus, in gastric adhesions, if pressure is made on the anterior abdominal wall in an upward direction, from the region of the lower border of the stomach, the pain which is present on ordinary manipulations is greatly increased.' If the adhesions are on the right or on the anterior border of the stomach, pressure made over the epigastrium will cause the pain to shoot out from the right over the area of the adhesions. If they are on the posterior gastric wall, pressure over the first and second lumbar vertebræ will often cause pain. Adhesions between the anterior abdominal wall and stomach are not so frequent, and are very apt to be confused with gastric ulcer. Pain due to intestinal adhesions, as a rule, is sudden and acute, and is the result of stenosis of the gut by the adhesions; generally it is of short duration, disappears as quickly as it came, and is frequently followed by a discharge of fluid feces or flatus.

Intestinal Adhesions.—An interesting case of intestinal adhesions is that of a young lady, whose history is as follows:

Nearly two years before admission to the hospital she began having acute pains in the abdomen, of a spasmodic character. During the past year these have become more frequent and are accompanied by vomiting and eructations of gas. The attacks seem to be brought about by eating indigestible foods and exposure to colds and dampness. She has had two attacks at night without apparent cause. The menses are painless. The pains are always relieved by a bowel movement. At first they are diffused over the abdomen, but soon show a distinct right-sidedness. During the last attack the pain was mostly toward the median line, slightly to the right.

Operation showed the cecum and adjacent intestinal coils all matted together by dense adhesions, which, in some places, were so thick that they had to be cut between ligatures. A tumor, corresponding in location to this mass, was felt on the right side before operation.

Pelvic Adhesions.—Pain due to pelvic adhesions is present (a) at stool, (b) during micturition, (c) during the menses, (d) on moving, (e) on subjecting the body to light shock, and (f) during coitus.

A case in point is that of Mrs. X——, whose ovary and tube on the right side, and appendix were removed, drainage being inserted because of the pronounced gangrenous state of the appendix. Some weeks after operation she complained of aching which was worse after moving, after lying down at night, and on sweeping. This aching begins in the lower right middle region anteriorly and extends through to the back in the lumbar region.

Another case is that of Mrs. Y——, in whom pain began in the right side and was constant. She had a feeling as though a knot were being tied inside her. On the same side a small mass was present. A year previous she had had an operation performed, in which the ovaries were removed. In this case there was present a band of adhesion, extending from the uterus, its appendages, and the intestines, to the lateral pelvic wall.

General Peritoneal Adhesions.—If the pain is due to generalized peritoneal adhesions, for instance those following a gastric perforation, it is often present after eating, and comes on when the stomach is full or when the patient assumes certain positions.

Pritchard (620) reported a case of abdominal pain, in which the diagnosis was obscure, but on operation adhesions were found between the stomach and the anterior abdominal wall. No previous symptoms indicating inflammation could be elicited; no ulcerated areas, nor indications of ulcer, could be found. After reviewing the case and excluding the gall-bladder, stomach, or duodenal ulcers as the cause of the adhesive formation, Pritchard, because of the presence of an edema of the lower extremities, without sufficient cause in the same patient a year or two previously, offered the novel explanation that the edema was due to neurotic influences, and that the abdominal adhesions were the result of the same influences acting in the abdominal cavity so as to produce edema of the stomach and duodenum, and consequent adhesive formation.

Nature of Pain in Hernia. Because of the mechanical relationship of hernia to the abdominal structures, it has been thought wise to consider it in this section. Pain is not a prominent symptom of *simple uncomplicated hernia*, except in those cases wherein the hernia is of sudden development. Here the pain is due to: (1) Traction on the mesentery. This occurs in the early stages of the condition. Later the pain is due to: (2) Inflammation of the bowel, which is the result of deficient circulation, edema, and the presence of toxins. This inflammatory process causes the contents of the hernial sac to swell, and, if the neck is small, the hernia becomes strangulated, and the traction and pull upon the involved mesentery are increased. The inflammatory process may also extend to the parietal peritoneum, and to the pain of the traction there is also then added the pain of the peritoneal irritation. (3) Peritoneal irritation. The inflammation may progress to such an extent that adhesions finally form between the peritoneum and the bowel, and then every movement may be capable of producing pain of a dull, dragging character. Thus pain of hernia may be due to involvement of the mesentery, the bowel, or the peritoneum.

The mesentery as a factor in the pain production is generally of little moment unless the onset of the hernia is sudden, when there is present, in the majority of cases, a severe, dragging pain, most frequently about or above the umbilicus, if the hernia is of the small intestine; while if it is of the lower bowel, the pain or distress is generally below this level. The mesentery probably also receives a few fibers from the cerebrospinal system; and, when irritation to them occurs, the resulting pain is generally referred to their somatic distribution. When this is the case, the area of tenderness and of subjective pain is generally outlined by the area of distribution of one or more of the spinal nerves.

The ilioinguinal nerve passes out of the abdomen at the external abdominal ring, and is distributed to the ilioinguinal region of the upper and inner part of the thigh to the scrotum in the male, and to the labium in the female; hernia, producing pressure on this nerve, causes pain to be felt as coming from these parts.

Bowel pain proper differs from that of hernia, in that the pain sensation is due to the carrying of stimuli to the cord, where some of the cells of the spinal nerves, being stimulated, give rise to pain sensation, which the brain interprets as coming from the peripheral distribution of these fibers. The area of tenderness and subjective pain felt in the distribution areas of these fibers does not follow the plan of distribution of any spinal nerve or nerves, but is located in the area of distribution of fibers arising from certain cord segments, as marked out by Head. The points of tenderness, which, in many cases, bear no definite relation to the lesion causing the trouble, are but the maximal points of tenderness of these cord segments. If the hernia is in the small intestine, the most common site of the referred pain is in the region of the umbilicus, while in involvement of the large bowel the pain is located as being below this point; if peritoneal irritation is present, a local tenderness is felt at the place of the lesion. A part at least of this bowel pain is due to distention of the involved portion of the bowel by gas. When this factor is present, the pains are generally paroxysmal, occurring at the time of the bowel distention, and are eased as soon as the gas and the fecal contents have passed on; but should the swelling at the neck of the sac increase, the hernia then becomes strangulated, and to the other factors producing pain is then added a third, namely, peritoneal irritation.

In *peritoneal irritation* the pain at first is slight, and similar to that described above; but after it once develops, it is so much more severe than the other two that they are of minor importance. The tissues are now exquisitely tender, and are sensitive to the slightest pressure. It is at this stage that, in case of femoral or inguinal hernias, the patient instinctively draws up and rotates inward the leg of the affected side.

The *omental hernias* are generally not very painful, because the omentum, of itself, has little pain sensibility; but, in some instances, as in a case of ventral hernia, where the patient had suffered from cramps and severe abdominal distress, with vomiting, an operation showed a small omental ventral hernia about two and one-half inches above the navel and a little to the left of the median line. There was no localized tenderness.

Pain, as a symptom of simple uncomplicated herniæ, is generally of minor importance. Few of the cases of hernia are acute in their onset, most of them being the gradual development of years; and even when the hernia is acute, the pain symptoms are not of special diagnostic importance, only in so far as they indicate the special region of the bowel attacked, and the magnitude of the involvement. In chronic cases there may be a smarting or burning, which De Garmo thinks most likely indicates an omental protrusion. The most common pain is of a dragging nature, and is worse in the evening and better in the morning, because during the night the intraabdominal pressure is relieved.[1]

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[1] Sir William Bennett (*Lancet*, Feb. 2, 1907, p. 270) mentions a case in which the hernial sac had a very small opening; and he suggests that it was due to the accumulation of fluid in the sac, as the day went on, which caused the pain to be so much more pronounced toward evening.

Anything causing a rise of the intraabdominal pressure, such as coughing, sneezing, straining, or lifting, is likely to produce this pain.

Strangulated hernia generally gives rise to the greatest distress, very often present around the umbilicus, and when this is associated with vomiting the diagnosis of gall-stone colic or gastritis is very apt to be made, and the hernial condition neglected, while the patient goes rapidly on to his death.

In some cases of STRANGULATED HERNIA the pain begins about the umbilicus, and thence, as the severity of the lesion increases, radiates to the region of the strangulation.

UMBILICAL HERNIA is generally associated with considerable local and referred pain, most of which is probably due to traction on the stomach from the involved omentum, adhesions existing between either the stomach or the adjacent omentum and the anterior abdominal wall.

In INGUINAL HERNIA forcible extension of the thigh is painful. In some cases of inguinal hernia, also, the pain may be felt in the epigastrium, and radiates to the back, as in a case reported by Witherspoon (125, p. 219), in which the patient complained of pain in the epigastrium radiating to the back, and of tender areas on either side of the vertebral column opposite the eighth and ninth thoracic vertebræ. Abrupt pressure over the epigastrium, centrally, and to either side, over the recti muscles, excited severe paroxysms of pain. *Gradual pressure was well borne.* Operation relieved the condition.

The following is a case of pain due to inguinal hernia.

The patient complained of pain, or rather of a dragging sensation, running from the region of the pubic spine downward and inward to the scrotum. This pain was made worse by walking, by lifting, or even by sitting, and was eased on lying down. He would be all right in the morning, but as the day wore on he would become so ill that he would have to give up his work, which was that of a driver on a grocer's wagon. On releasing the hernia, the pain entirely disappeared. The sac did not seem to be adherent to the surrounding fascia.

Stockton, in speaking of inguinal hernia, describes a condition in which the complaint is pain generally referred to the lower quadrant of the abdomen; it is of a colicky character, and is sometimes burning. There may also be present continuous suffering. These symptoms are relieved when the patient lies down, and are increased on active movements, also in lifting. They appear and disappear at irregular intervals. Examination discloses a patulous internal inguinal canal, not large enough to permit a well-marked hernial protrusion, but sufficient to cause a bulging outward of the peritoneum, which is made worse by coughing or straining.

EPIGASTRIC HERNIA.- Epigastric hernias sometimes simulate gall-bladder or duct disease, or even a gastric disorder. They are to be differentiated from the small subcutaneous tumors found in the epigastrium, and are due to the protrusion of small, fatty masses through openings in the anterior abdominal wall.

Hernias of the anterior abdominal wall sometimes produce symptoms of pain which disappear on lying down. Examination may elicit no apparent abnormality, and the physician is at a loss to account for the persistent cryptogenic pain which recurs so regularly on motion, or on the performance of tasks involving an increase of the intraabdominal pressure. In many cases, while a superficial examination shows nothing, a more thorough one may reveal some slight thickening, or some little localized swelling of the abdominal wall. When this is found, hernia should be thought of. When small, there are no absolute diagnostic criteria of a hernia of this character; but if it is large and reducible, the gurgling accompanied by the disappearance of the tumor on reduction indicates the condition. McEwen (919), in speaking of small umbilical hernias, with a very narrow and distensible sac, states that the pain (violent abdominal pain) frequently comes on at an early stage, before any prominent external tumor has appeared, and he attributes the pain in such cases, in part, to the cupping of a portion of the bowel in the narrow mouth, and in part to the distention of the narrow mouth, causing pressure on, and irritation of, the peripheral nerves.

The pain of FEMORAL HERNIA in the male may sometimes be referred to the penis.

DIFFERENTIAL DIAGNOSIS—ABDOMINAL LESIONS WHOSE PRINCIPAL SYMPTOM IS PAIN

SYMPTOM	GASTRALGIA	GALL-STONE COLIC	ACUTE PANCREATITIS	DUODENAL ULCER PERFORATION	GASTRIC ULCER PERFORATION	GASTRIC ULCER NON-PERFORATING	CHOLECYSTITIS
Remarks......	Probably no such entity. No objective symptoms.	Gall bladder often enlarged so that it can be palpated. Attacks may pass away entirely without further symptoms.	Sudden onset associated with collapse.	Signs of collapse. Previous history of vomiting and pain a long time after eating History of previous digestive disturbances not so common as in gastric ulcer.	Previous history of vomiting of blood, etc., i. e., a history of gastric ulcer (q. v.).	Vomiting of blood. Pain after eating. Pain eased by eating of proteids.	**Enlarged gall bladder can often be felt. It also is very tender.**
Pain...... ..	Relieved by pressure. Brief duration.	Gradual in onset, increasing to a climax. Radiates to the right shoulder.	Sudden epigastric.	Sudden, generally follows exertion or straining of some kind. Pain and tenderness gradually extend over the entire abdomen, indicating a beginning and then a general peritonitis. Pain and tenderness gradually tend to become localized in the right iliac fossa.	Sudden, epigastric, more to the left side than the pain of perforating duodenal ulcer generally follows exertion. Points of tenderness generally coincide rather closely with points of subjective pain.	Sharp pain generally in epigastrium midline of body: the nearer to the pylorus is the ulcer, the nearer to the umbilicus is the pain.	**Short, localized. The pain has a tendency to radiate, either to the back (under the right scapula) or to the right shoulder. If the duct is entirely blocked it may remain constant and be very severe.**
Chills........	No chills.	Often present.	Present.	Generally present.	Generally present.	Not present.	**Present; rather severe in some cases.**
Temperature...	No fever.	Often a slight rise.	Present.	At first a sub-normal temperature, and then, as peritonitis begins to spread, a gradual increase in the temperature occurs.	No rise of temperature at first shock, then a gradually increasing temperature.	No rise of temperature.	**Rise of temperature.**

CHAPTER XX

PAIN IN ABDOMINAL VISCERAL DISEASE

History.—The question of the sensibility of the abdominal viscera is one which has been much discussed, and, at the present time, it cannot be stated with certainty that the problem has been definitely solved. As long ago as 1753 Haller had noted that he failed to obtain evidence that the internal viscera were sensitive to painful stimuli, but it has become increasingly evident that the nervous mechanisms of the visceral activities are exceedingly manifold, and that no adequate explanation of their functions is possible without a searching investigation of their rich nervous supply. The work of Lennander and Mackenzie seemed to point to the fact of there being no pain fibers in these nerves, but that of Ross, of Kast, and Meltzer has shown that the observations of previous experiments were faulty and that the ordinary tests which they used for the elicitation of pain phenomena in the viscera, which were the same as those used to elicit pain response in the skin, were not suitable, since the viscera, because of their structure and position, are non responsive to these stimuli, but may respond to other forms of stimuli than do the skin and mucous membrane.

The ordinary facts of digestion prove the response to chemical stimuli, and also to those of heat and cold, and it is becoming apparent that some modification of the earlier views must take place.

The sensibility of the abdominal organs has been, for many years, a question of debate between two opposing schools, the one maintaining that the abdominal viscera of themselves were not capable of producing pain phenomena, the other holding that they were. Evidently both were right to some extent, for it has been found that organs which under normal conditions do not produce pain will, when inflamed, give rise to pain phenomena (Rosthorn). However, in many cases it must be admitted that the sensibility to pain shown by the abdominal organs is very unusual, for in many cases operative interference may be undertaken without excessive pain production, ovariotomies having been performed by Riedel (865) and Johnnen without any especial pain. The uterus is painful only when inflamed (Bernard, 867). All varieties of abdominal operations were performed by Lennander without pain production, except when traction was made on the mesentery.

For a better understanding of pain production in visceral disease, it may be well to review the *innervation* of the abdominal viscera. The innervation of the viscera is from both the cerebrospinal and the sympathetic system. The cerebrospinal or medullated fibers are carried in the vagus and in the splanchnics, and are distributed to the various abdominal plexuses. Where they finally terminate is an undetermined question, but it seems likely that they end in the mesentery. The sympathetic has its own special nerve system—its fibers pass on farther than those of the cerebrospinal system, and are ultimately distributed to the abdominal organs, whose functional activities they coördinate and regulate. They consist of vasoconstrictor, vasodilator, motor, and inhibitory fibers, etc. (Tigerstedt). They originate in the lateral horn on the same side of the cord in which they are found, pass through the posterior ganglion into a nerve trunk, and finally end in a ganglion, from which fibers are carried to the ultimate distribution area. These ultimate ganglion cells have no connection with each other. All the sympathetic fibers do not arise in the cord, many of them arising in the posterior ganglia, or from the abdominal ganglia themselves. Mackenzie, Peterson (72), and others hold that the sympathetic system is oldest in origin, and that the cerebrospinal system is merely an outgrowth of the sympathetic, and has been built up for its protection. This may be, as remarked by Mackenzie, the reason for its proneness to convey pain, one of the functionally protective sensations. In this way

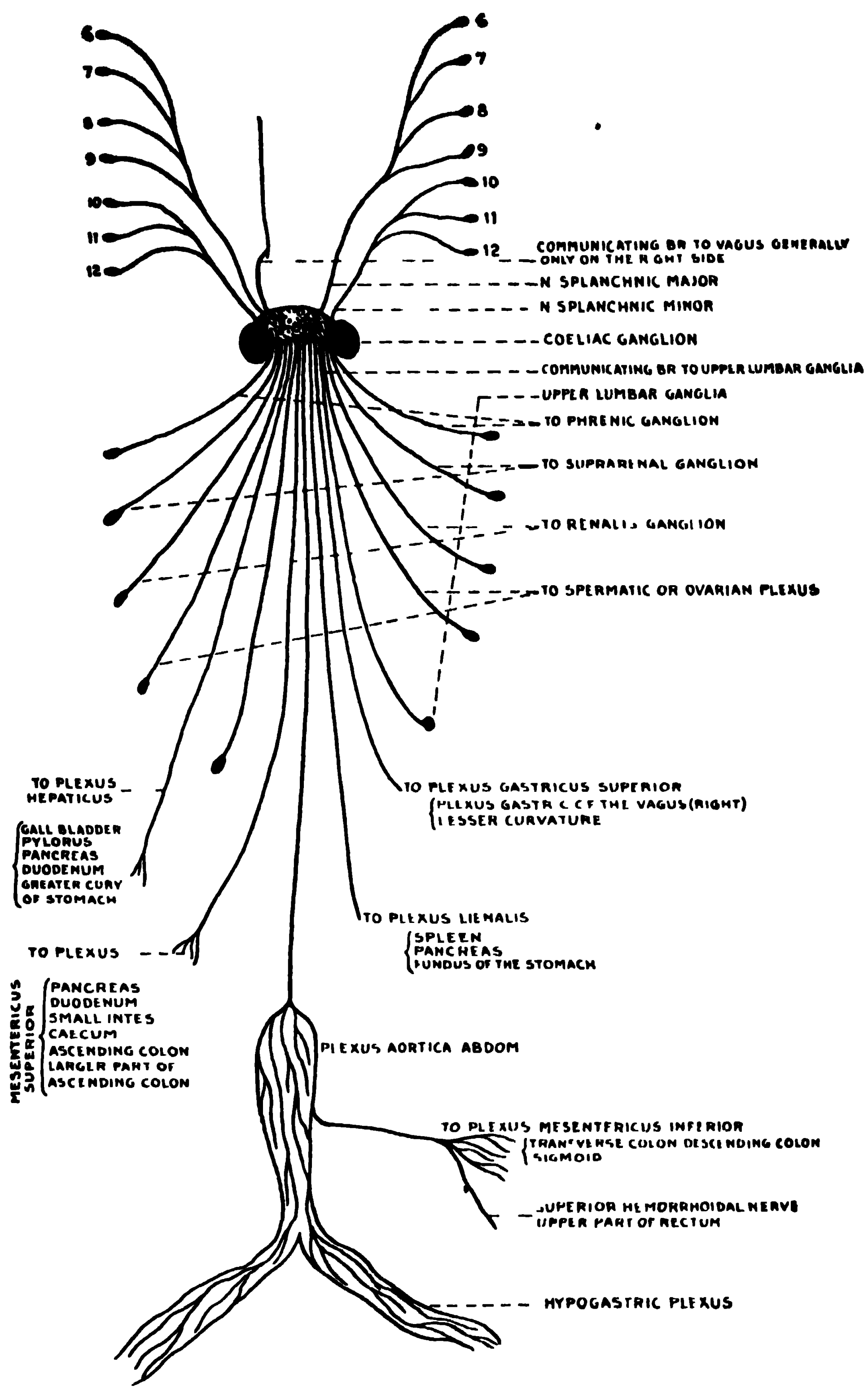

FIG 81 —SCHEME OF INNERVATION OF ABDOMINAL VISCERA.

The above diagrammatic drawing shows the reason for the tendency of diseases of the gall bladder, pancreas, duodenum, the pylorus and the greater curvature of stomach, to cause pain on the right side of the body, while lesions of the lesser curvature, fundus, spleen and pancreas have a tendency to produce pain on the left side of the body. Drawing modified from Spalteholz.

it guards, against injury, the internal organs supplied by the sympathetic, which ordinarily has no direct pain-conducting sensibility, as such is generally understood. The sympathetic contains both afferent and efferent fibers, but it is only the afferent which may, under unusual circumstances, be concerned in the conduction of pain stimuli. Ordinarily, these nerves are incapable of conveying impulses which are interpreted as painful; but under certain modifications, such as are produced by injury, a change of irritability may take place, so that stimuli which ordinarily do not produce pain now give rise to the most excruciating agony. Such modifications have been observed, especially by Buch and Mackenzie. Buch, on correlating the researches of Wutzer, Florens, Brochet, Valentin and Longet with his own clinical findings, concluded that a normal sympathetic nerve is incapable of carrying pain-producing stimuli; but that, when inflammation ensues, some change in its excitability occurs, so that, instead of the dull perception, which it previously had, it acquires an exquisite sensitiveness, so that pinching, pressing or dragging on it is very painful. This increase of sensitiveness can also be produced by continued electrical stimulation, or by stretching of or pressing upon the nerve (Lemmering). Ritter, after experimenting on dogs, concludes that the fibers conveying the impulses interpreted as painful run in the nerves distributed to the blood vessels, for he found that ligation of the vessels was much more painful than irritation of the parietal peritoneum or traction on the mesentery. This is in accord with the statement made in a previous chapter, to the effect that in the internal organs it is probable that the sensory fibers accompany the vasomotor nerves. Should such be the case, it is likely that the pain-conveying fibers are collected into the same ganglia, or in the ganglia associated with those of the vasomotor nerves. It has been found that the vasomotor center for the stomach and upper intestine is in the plexus cœliacus (Buch, 171; Pincus, 465; Budge, 466; Techlenburg, 467; Lowen, 468, and Boer) while Laignel Levastine located the vasomotor center for the liver in the right semilunar ganglion, and the vasomotor center for the spleen in the left semilunar ganglion, and the vasomotor center for the small intestine and the upper part of the large intestine in the superior mesenteric ganglion. From the association of the vasomotor and sensory fibers, it would seem that these ganglia also are the sensory centers for the dependent organs. Lennander, however, states that it is traction of the mesentery which, in turn, produces pull and traction on the sensory (cerebrospinal) filaments in its substance that produces the visceral pain. The apparent discrepancies between the statements of Ritter and Lennander may be due to the fact that Ritter's observations were made during experiments on animals, while Lennander's were made during abdominal operations. On one fact all observers are practically in accord, and that is that the parietal peritoneum is very sensitive; and there is also concord in the belief that the viscera themselves are but slightly sensitive to pain. These latter views are in accord with observations of physicians from time immemorial. Perhaps the oldest example is in Xenophon's "Anabasis," wherein mention is made of Nakarchos, the Arcadian, being wounded in the abdomen in battle, and coming in flight, holding his entrails in his hands. Then, as we pass down the ages, here and there examples are given of the insensitiveness of the internal viscera. Haller, about one hundred and fifty years ago (1753), noticed that the liver, spleen, kidneys, heart and lungs possessed little sensibility; that the parietal peritoneum was slightly sensitive, while the visceral peritoneum was entirely without sensation. He also states that the subcutaneous coat is very sensitive, while the mesentery has no sensation. In this connection, I shall quote *in extenso* from Meyers, who has so well described the progress of our knowledge in this direction. He says that "Bichat noticed, at the end of the eighteenth century, that electrical, chemical and mechanical stimulation of the organs supplied by the sympathetic system do not produce pain." This agrees with the clinical findings of Prony (343), who states (1821) that Bichat had seen dogs devouring their own intestines and tearing their own peritoneum, which had prolapsed through abdominal wounds. Many observations have been made on man, seeming to show absolute insensitiveness of the abdominal viscera

(Mitchell, 263, in the year 1872; Bier, 331; Mackenzie, 332; Lennander, 380; Hofmeister, 869; Cushing; Block, 870; Mitchell, 840; Partsch, 871).[1]

The absolute reliability of these deductions has been questioned by Kast and Meltzer, and more recently by Neuman. Kast and Meltzer claim that the insensitiveness to pain present in the abdominal viscera under local cocain anesthesia is due to the general toxic action of the cocain, which so reduces the sensitiveness of the internal viscera that they no longer respond to stimuli, to which, without the cocain, they would respond and which, being carried to the cerebrum, would be interpreted as pain. These deductions are apparently controverted by Mitchell (155, pp. 200-201), who, under hypodermic subcutaneous injection of normal salt solution, was able, after the peritoneum had been opened and the intestine delivered, to seize it with a clamp, rub it with gauze, and prick it with a needle, all without the production of pain.

The pain sensations from the abdominal organs are probably carried chiefly by the vagus and the greater splanchnics; both contain medullated fibers, found, according to Edgworth, in the vagus at the level of the diaphragm. This view is opposed to that held by Lennander and Meyers (122), that the sensory fibers of the vagus do not extend below its recurrent laryngeal branch. Edgworth also makes the observation that on the warming of the vagus its conductivity seems to increase.

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[1] It is claimed by Lennander that none of the abdominal viscera is sensitive to pain, and that when pain occurs it is due to the following causes (given by Kast and Meltzer, 134, pp. 1017-1019). (1) pressure, sliding or pulling of the parietal peritoneum; (2) pulling of the mesentery, and thus irritating the posterior wall of the abdominal cavity, which is provided with pain fibers derived from the spinal nerves; (3) lymphangitis and lymphadenitis occurring and reaching the nerves of the posterior wall; (4) irritating toxic products or chemicals, like HCl in gastric ulcer, reaching the lymphatics of the posterior wall.

Maunsell Moullin says that the effect of traction on the mesentery is the same, whether there is a "free mesentery or whether the peritoneum is reflected from the sides of the viscera, leaving a portion of the circumference of the bowel attached to the parietes by cellular tissue" (Moullin). In this case, besides the stimulation of the nerves in the peritoneum, there would be traction upon the nerves in the connecting tissue. These nerves are derived directly from the cerebrospinal system, and any traction upon them would be referred as pain to the distribution area of their somatic branches. It is a well-known fact that the surfaces of the internal viscera are not painful to pressure, pinching or squeezing, nor to heat and cold. Their only function is reference of impulses having to do with the well-being of the organism; and in cases of inflammation, as suggested by Lennander (23), it is possible that toxins may be carried by the lymphatics to the nerve filaments, thus rendering them more sensitive, so that they respond to stimuli with a reaction which is called pain. Inflamed organs are slightly more sensitive than organs not inflamed.

As to the manner of production and conduction o' the visceral pain impulse little is known, though it is held that the pain is: (1) "due to induction of a current in adjacent fibers in a manner comparable to the electrical induction in two adjacent but unconnected nerves" (probably not correct); or (2) that the "nerve center, spinal or cerebral, which receives the afferent impulses is so unduly excited that in its disturbed condition it attributes the afferent impulses to the wrong afferent nerve"; or it may be possible (3) that "transference may take place in the sensorium." Although the method of the production and conduction of the impulse is in doubt, yet no doubt exists as to the actuality of its presence. A peculiarity of its perception is that it is not felt in the organ in which it is produced, but is referred or reflected to the body wall, where it becomes either the so-called somatic pain, or is perceived as a form of hyperalgesia.[1]

Location of Pain.—That the pain of visceral disease is not necessarily located directly in the involved viscera may be seen from the following:

(1) On movement of the involved organ there is no change in the character or location of the pain:

(*a*) Movement of the heart produces no change in the character of the anginal pain. If the pain were in the heart itself, each contraction of the heart would produce a change in the character of the pain.

(*b*) Peristaltic contraction of the stomach produces no change in the type of the pain of gastric ulcer; also, changes in the position of the stomach due to respiration produce no change in the location of the pain. If the pain were located in the stomach, movement or change in the position of the organ would of necessity produce a change in the character or location of the pain.

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[1] This view has recently been very strenuously opposed by Hertz, who claims that pain sensation can reside in the internal viscera themselves (Hertz, 106b, p. 48).

(2) The pain is not located directly over the diseased area in the involved organ; indeed, it may not even be over the organ at all:

(*a*) Cardiac anginal pain may be felt down the arm or even up in the neck.

(*b*) Pain of gastric ulcer is not directly over the site of the ulcer, as has been proved, time after time, by operations.

(3) The area of hyperesthesia may be distributed over a much wider area than that under which the organ is located.

Transference of Pain.—Because of the apparent non-location of pain in the diseased viscera producing it, many attempts were made to explain the relationship between the area of pain and disease in the viscera. The most successful of these was by Head, who, in a thesis read before the University of Cambridge, in June, 1892, and before the Neurological Society of London, November 10, 1892, first opened the way for the study of peripheral sensory manifestations of visceral lesions. He claimed that the manner of transference of pain sensation is this: that the stimulus affects the peripheral distribution of a nerve distributed to a viscus, and that this stimulus is carried to the cord and enters the sympathetic system through the sensory root posterior to the ganglion. In the cord the nerve cells of these fibers (from the sympathetic) come into intimate contact with the cells of the fibers from the peripheral sensory system, and incite them to reaction, so that stimuli occur, and are transmitted to the brain, so that the brain centers perceive them as coming from the peripheral distribution of these same somatic or body nerves.

By a reference to Figs. 31, 32, 33, it may readily be seen how the stimulus can be reflected from one set of neurons to another set; and it is thus that the excessive irritative stimulus arising in the splanchnic area is interpreted in some distant area as pain. Head has laid down a law particularly applicable to this state, namely, “that where a painful stimulus is applied to a part of low sensibility, in close central connection with a part of much greater sensibility, the pain produced is felt in the part of higher sensibility, rather than in that of lower sensibility to which the stimulus is actually applied.”

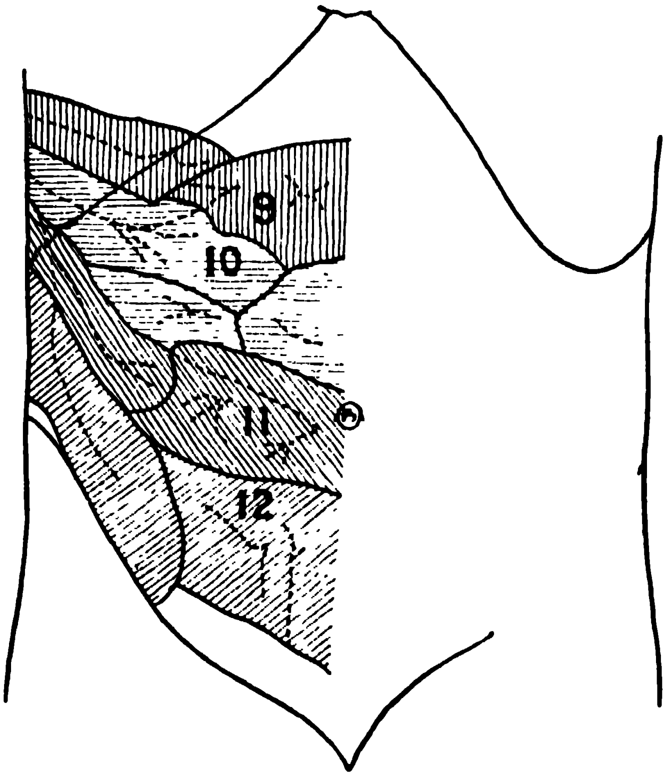

Fig. 82.—Figure Showing the Anterior Dsitribution of the Ninth, Tenth, Eleventh and Twelfth Dorsal Nerves.

The shaded parts indicate the areas in which pain is most frequently observed in abdominal visceral disease.

Wilamowski’s (109 b) experiments, while confirming Head’s deductions, show, in some cases, areas of reduced sensibility corresponding in outline to the areas of increased sensibility in other cases. He believes that this hypoalgesia obeys the same laws and is subject to the same influences as the corresponding hyperalgesia, and that both are of the same origin.

In this relation it was noticed by Mackenzie that in but very few cases does the hyperesthesia associated with visceral disease occupy the entire area of distribution of a particular nerve, as the area of cutaneous hyperesthesia associated with cardiac disease does not extend throughout the entire area of distribution of the fourth dorsal nerve, but is generally confined to the skin on the anterior surface of the chest. It does not pass around to the posterior surface; also, it is sharply delimited at the clavicle, and does not spread upward into the area of distribution of the fourth cervical, which lies above the clavicle. It may extend down the inner side of the arm and forearm into the areas of distribution of the second and third dorsal. Mackenzie (110b) claims that these fields of hyperesthesia are not accurately defined, that they may overlap each other, and that they are not particularly limited to any definitely defined, special area. These areas of hyperalgesia of Mackenzie are most likely nothing but the zone areas of hyperalgesia, as described by Head, whose work at that time was unfamiliar to Mackenzie.

In some cases the visceral lesion may produce an irritable focus in the cord, so that stimuli coming to this place would be perceived as pain, while normally they would not be so perceived, or, in some cases, would not be felt at all. For instance, the liver and the stomach receive their nerve supply from the same segment of the cord. Liver disease may produce such an irritation of this segment, that, on the entrance of food into the stomach, the nerve impulses from the stomach to the cord, which ordinarily are not painful, would then be perceived as painful. Such examples we all have seen, and, in many cases, they lead to a wrong diagnosis (Mackenzie).

Persistence of irritability of associated segmental areas of the cord may explain the presence of hyperalgesia, due to excitation of these associated areas. Thus, in a case of gall-stone colic (Mackenzie), in which there was jaundice, there was also extreme hyperalgesia of the skin of the upper part of the abdomen, especially marked in the epigastrium. This persisted for some days after the stone had been passed and had been found in the stool. During the time the hyperalgesia persisted food taken into the stomach produced severe pain in the epigastrium. With the disappearance of the hyperalgesia of the skin the pain on taking food ceased.[1]

Mackenzie, in continuing, says that "here there seems little doubt that the stimulation, set up by the ingestion of food, which passes to the spinal cord normally unperceived, reached that portion of the cord which had been abnormally excited by the gall-stone colic, and had hypersensitized the centers of the cutaneous nerves for pain which supply the epigastric region."

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[1] This association of pain with the ingestion of food may also be due in many cases to the associated peristalsis set up in related organs by the entrance of the food into the stomach.

Shock, also, sometimes affects certain cord areas, as in persons who experience pain in a certain area (hyperalgesic) when startled. Mackenzie's explanation is that when startled a stimulus passes down certain tracts in the spinal cord, affecting normally the centers of the muscular nerve supply, as evidenced by the sudden contraction of nearly all the muscles in the body. The stimulus is not of sufficient strength to affect the sensory nerve centers in a healthy cord, unless there are abnormally irritable foci in the cord. However, if such should be present, the stimulus in passing through them affects the excitable sensory nerve centers, and pain arises and is referred to the peripheral distribution of the nerves stimulated. It may also happen that pain is produced by a stronger and more powerful contraction of the excitable and hyperalgesic muscles.

Some mention should be made of the views of Hertz, who has carefully discussed this whole question in his 1911 Goulstonian lectures ("Sensibility of the Alimentary Canal"). He points out that Lennander and Mackenzie did not take into consideration the fact that a nerve ending may be sensitive to one form of stimulation and may be insensitive to another. The one is an adequate, the other an inadequate stimulus. The eye does not react to sound stimuli, nor the taste buds to those of light. Thus, the abdominal viscera, not being exposed to touch, are probably not stimulated by touch stimuli, but that they react to adequate stimuli there is no question. All that the older observers showed was that pinching, pricking, cutting were not natural, adequate stimuli. The fact of the matter is that the abdominal viscera are exquisitely sensitive to deep-pressure stimuli, such as those produced by tension. Thus, slight distention of the intestinal muscular coat leads to discomfort, and marked stretching to severe pain.

The normal stimuli reactions in the intestine are those of contraction and relaxation; these two are going on continuously. There is, as Meltzer has pointed out, a law of contrary innervation, which permits of this wave of contraction and relaxation, and any interference with this law, such as occurs in colic, in obstructions, etc., gives rise to paroxysmal and severe pain.

The pains of gastric ulcer and duodenal ulcer are to be thus interpreted. In colic an abnormally strong peristaltic wave occurs in one part of the alimentary canal, the part immediately below which should normally relax, following the law of contrary innervation, is unable to do so, owing to organic disease, or to spasm; the intermediary segment is thus subjected to steadily increasing pressure, which soon produces pain, the distention being the adequate stimulus.

Hertz believes that the only cause of true visceral pain is tension. Thus, a study of the visceral pains resolves itself into an analysis of the two forms, the tension pains and the reflex pains, which, as has been pointed out, are exceedingly rich and varied, and of great diagnostic value topographically.

Even with the adequate stimulus, however, the intestines are much less sensitive than is the skin to its adequate pain stimuli. The inaccuracy of localization of the tension pains is no argument against them, since the brain is the perceiving organ and it registers the general topography of an organ, not its variations in location, as, for instance, in the movements of the stomach. Thus, there is no valid reason why the pain of a gastric ulcer should vary with every movement of that viscus. With the viscera, however, which move the least, the localization of pain remains the most stable, other things being equal.

Should the resistance of the patient be lowered from any cause, such as occurs in the anemic and weakened state which follows upon a severe fever or illness of any kind, it has been found that reflected and referred pains are much more likely to occur.

After the elicitation of referred or reflected pain, it is necessary to localize the viscus producing it. The technic is the following: (1) delimit the area of hyperalgesia as nearly as possible, and orient it with a cord segment; (2) find out what organs are supplied by this segment; (3) examine the organ or organs for disease; (4) see if, by manipulation of the organ, the pain can be reproduced.

The transmission of stimuli to the cord also affects the muscular centers which lie adjacent to the sensory centers involved. These stimuli augment that which is normally present in the muscle, and, instead of the normal tonicity, cause a state of tonic contraction. This contraction may be limited to a portion of a muscle, may involve the entire muscle, or may affect several muscles whose centers lie adjacent to each other. This muscular center hypersensibility also accounts for the exaggerated reflexes (principally abdominal) which are so often present in visceral diseases.

As irritation of the viscera causes pain to be referred to certain areas, it has been found that stimulation of these areas also is referred back and causes reflex changes in the viscera.

CHAPTER XXI

DIAGNOSIS OF ABDOMINAL PAINS

NATURE OF VARIOUS ABDOMINAL PAINS

The lesions of the abdominal viscera producing pain are principally those which cause contraction, active spasm, or excessive passive dilatation of the involuntary muscle fiber in the walls of these viscera. Inflammation of the viscera also causes pain; but in many cases ulceration of a hollow viscus may exist for years without producing the slightest distress. This is well exemplified in ulcers of the stomach, gall bladder and appendix (Moullin and others).

In nearly all cases in which a severe and long *contraction* of a hollow organ is present, there is, above the area of contraction, an area of dilatation, so that, at the junction of the contracting segment with the dilating segment, a place is present where traction on the mesentery is severe and prolonged. It is likely that this traction and pulling cause the excruciating pain of intestinal and other hollow viscera colics.[1] That excessive passive dilatation of an abdominal organ may cause pain, is verified in many cases, such as when tympany of the stomach or colon, with severe pain, comes after operation. After relief of the dilatation by the passage of the stomach or rectal tube, the pain disappears. Many have experienced the sense of discomfort and distention after the ingestion of a hearty meal, and it is easy to understand how this disagreeable sensation, if the distention of the stomach were prolonged beyond the limits of its normal capacity, might be increased to one of actual pain. There are many cases, also, in which, during dilatation of the stomach for the purpose of recording its capacity, the patient complains of a sharp pain in the epigastrium. These are but isolated examples of conditions which are very common.

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[1] Hertz claims that colic is due to an irritation directly on the sensory terminal fibers in the muscle layer of the visceral walls.

In the *spasmodic contractions* and the *dilatations* of hollow viscera the pain is generally referred to the body wall, and hence is called somatic. The point of reference, in many cases, is some distance away from the location of the lesion. Thus, the pain felt in stomach distention is in the epigastrium, immediately beneath the ziphoid cartilage, at a point that is somewhat remote from the region of the stomach as projected on the abdominal wall. The logical way to explain the apparent non association of the area in which the pain is felt with the organ in which it is produced is that these remote regions are in relation with one another by means of nerve connections. An explanation of this seeming inconsistency may be formed from a study of cord zones, as elucidated by Head. It is known that the stomach is supplied by the seventh, eighth and ninth dorsal visceral zones, and that it is especially related to the seventh zone. It is also known that the maximum point of tenderness and sensibility of the seventh zone is in the epigastrium, immediately beneath the ziphoid. Therefore, in any lesion of the stomach which may be painful, the pain, as a rule, is reflected to this point, or to an analogous area on the back opposite the ninth or tenth dorsal spine. These pains are spoken of as reflected pains, and should more properly, perhaps, be considered under the class of pains which are felt at a distance from the lesions causing them, such as referred, reflected, transferred and associated or sympathetic pains.

Referred pain is frequent in lesions of the nerves or of the centers of these nerves, which supply the integument of the anterior abdominal wall.

Under referred pains are to be placed those due to tabes dorsalis, tuberculosis of the vertebræ, fracture of the vertebræ, osteoarthritis of the spine, insufficiency of the vertebræ, spinal meningeal inflammation or tumor, neuritis of the lumbar or dorsal nerves, pressure by growths, inflammatory products, or broken ribs upon the nerves, pinching of the nerves (especially of the last two intercostals) between the adjacent ribs, diaphragmatic pleurisy and rheumatism of the diaphragm, and aneurysm of the abdominal aorta. Acute mediastino-pericarditis, from direct extension, sometimes causes pain to be felt in the higher epigastric and lower breast region. For a proper consideration of all these pains, the reader is referred to the section under which referred pain is considered.

Reflected abdominal pains are the most common variety, and probably number fifty per cent. of all varieties of visceral pain. They are the result of a stimulus applied either to a sympathetic or to a cerebrospinal nerve. This stimulus is carried to the posterior horns of the cord, and actively stimulates other associated sensory fibers. The stimulus is then perceived as pain, and the sensation is referred to the peripheral distribution of the stimulated sensory neurons, and thus it occurs that the peripheral distribution of the pain may be in an altogether different region from that in which the stimulus originated.

Transferred abdominal pain is that form of pain in which the impulse is transferred, either directly across the cord to the other side, or to a higher or a lower level in the cord, thus changing the location of its peripheral distribution to a higher or lower level on the body wall. This is one of the most annoying pains to interpret. It may be found in the opposite side of the abdomen in appendicitis, pus tubes, diseased ovaries, renal calculus and pelvic peritonitis. Pain transferred to a higher or a lower level than that of the disease is illustrated by the abdominal pain in pneumonia (q. v.), the clavicular pain in extrauterine pregnancy, and the pains over the fourth costal cartilage (left side) in disease of the common duct.

The shoulder pain, which may be present in diseases of abdominal organs, has been considered by Peter to be due to phrenic nerve irritation, which carries the stimulus to the roots of the cervical nerves, from whence the sensation is referred as pain to their area of distribution (Mackenzie and Peter).

Sympathetic pains **are sometimes produced when the irritation of a center in the spinal cord is so great that other adjacent centers are stimulated and send impulses to the brain, so that pain is also interpreted as coming from their distribution areas.** This may happen in acute appendicitis when the cord segments above and below the segment connected with the appendix are irritated and refer pain to their area of distribution.

By reference to the diagram of pain paths, it may readily be seen how the various paths are propagated and conveyed. IT SHOULD ALWAYS BE BORNE IN MIND THAT IT IS IMMATERIAL WHAT PART OF A NERVE-CIRCUIT IS AFFECTED; THE PAIN WILL ALWAYS BE INTERPRETED AS COMING FROM THE PERIPHERAL DISTRIBUTION OF THE NERVE FIBERS WHICH ARE INVOLVED.

Regional Pains.—For the zone segments involved in disease of the different viscera see Figures 24, 25, 26. Each zone segment has one or more maximal points of tenderness which are sensitive in any painful disease of the viscera supplied by this special segment. It should be noticed that the term "painful" diseases of the viscera is used; for, as is known, every disease of the abdominal viscera is not painful; and while the majority of the visceral diseases at some period of their development become painful, there is a well-defined percentage which never do. The peculiarity of these nonpainful diseases may be accounted for from the fact that, in the evolution of the disease, the parietal peritoneum or the peritoneal attachments, as the mesentery, mesoappendix or mesocolon, have never been involved. We have already seen that Lennander explained all abdominal pain as a result of pulling, pressure or traction upon the peritoneum. In this relation, I would like, by means of an interpolation, to call attention to the experiences of physicians of a previous generation, who frequently groped in the dark in a vain attempt to correlate the symptoms and the disease seen in their patients. A case in point is one in which pain extended from the midline posterior above the hip to the midline in front, in which shingles were present. The patient, a woman, died on the third day of the disease, and on autopsy an inflammation of the peritoneum and appendix was found. "During life it was quite impossible to form a reliable opinion as to the nature of the lesion which gave rise to the pain. In view of our later knowledge, we would be able to diagnose the difficulty with ease" (McCall Anderson, 860). A full discussion of these views will be given in a subsequent chapter.

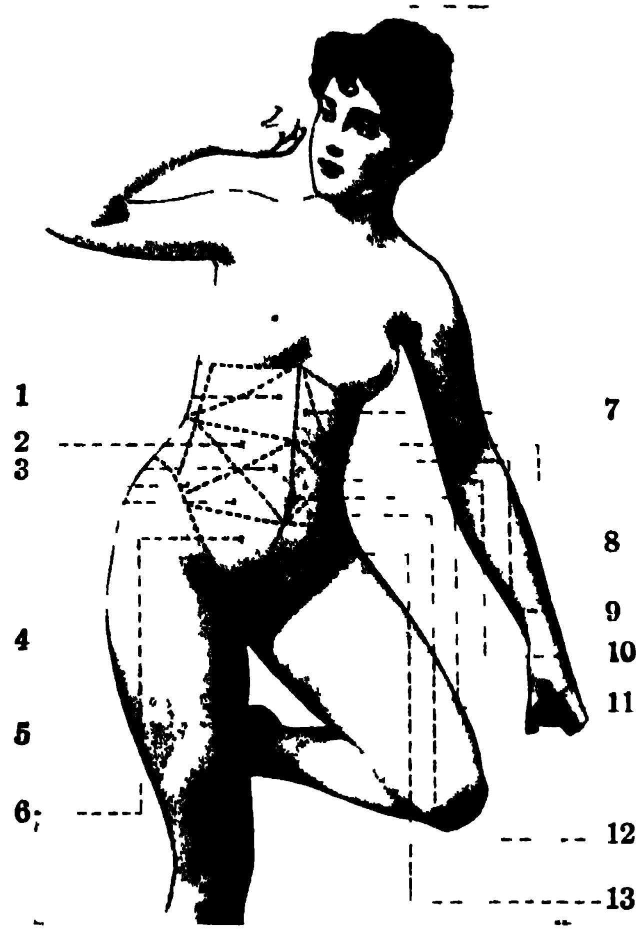
One of the first results of abdominal pain is the crippling of the respiration. This is noticed especially in men, who are accustomed to use the diaphragm in respiration much more than women. Where painful intraabdominal disease occurs, the diaphragm partakes of the reflex of all other muscles, and becomes rigid and motionless, so as to protect the diseased area. As a consequence, abdominal respiration is hindered or abolished.

EXAMINATION FOR PAIN

After this necessarily brief consideration of the pathology of various abdominal pains, it is in order to consider more closely, and in a more detailed manner, the routine examination for abdominal pain and tenderness. After that, it may be permissible to review the various divisions of the abdomen, and the pains which lie within their borders. In the examination of the abdomen for pain, the routine is as follows:

Localization of Pain.—The patient should be recumbent, the shoulders raised, knees flexed, mouth open, and the breathing regular and easy. The examiner's hand should then be laid flat over the abdomen, at first with very slight pressure, to elicit general tenderness; then the fingers should be pressed in with more force, in order to elicit localized tenderness at special points. The tips of the different fingers should now be successively depressed, in order to define more accurately the localization of the area of tenderness. After the location of an area of tenderness, it is well to determine its extent by concentric palpation. Concentric palpation is made by starting from the periphery and gradually making pressure towards the point of greatest tender-

ness. In this way the area of hypersensitiveness and the point of greatest pain are determined.



1

Liver
Gall bladder
Pancreas

2

Enlarged liver

3

Intestines
  Large
  Small
Enteritis
Lead colic
Omentum
  Cysts
  Carcinoma

4

Floating kidney

5

Appendix
Ovary
Fallopian tube
Typhoid fever
Referred pain
  Pleurisy
  Pneumonia

6

Uterus

7

Aneurysm of descending aorta
Stomach
Spleen
Pancreas

8

Intercostal neuralgia
Referred pain in pleurisy, pneumonia, pericarditis, appendicitis, visceroptosis

9

Splenomegaly

10

Kidney ureter
Descending colon (pericolitis)

11

Referred pain
Girdle pain of locomotor ataxia myelitis spinal meningitis
Arteriosclerosis of abdominal vessels

12

Ruptured extrauterine pregnancy
Hernia

13

Uterus(midline)
Ovary and Fallopian tubes (laterally)
Bladder
  Distention
  Tuberculosis
  Calculus
Ruptured extrauterine pregnancy
Hernia

FIG. 83.—ANTERIOR VIEW OF ABDOMINAL ZONES WITH CORRESPONDING ORGANS. Midline pain may be due to hernia of the linea alba. Pain over entire abdominal wall with tenderness on pressure indicates rheumatism of the abdominal muscles. Pain over any part of the abdomen may be found to be due to disease of the vertebra (caries, sarcoma, etc.)

Localization of the Organ Producing Pain.—After determining the presence of pain, it is in order to locate the organ producing it. For the purpose of localization, the abdomen is divided into three regions: (1) the upper, (2) the middle, and (3) the lower. The upper, which lies in the angle formed by the costal margins and a line connecting the lowest points on the costal arches, practically coincides with the epigastric area. The middle area lies between this zone and another line connecting the two iliac crests. Below this, and bounded at the base by the iliac and pubic bones, is the lower zone. Each of these areas is divided by a line extending from the ensiform cartilage to the pubes into a right and a left region, and the middle zone is divided by an imaginary line passing down the extreme lateral aspect of the body into an anterior and a posterior zone.

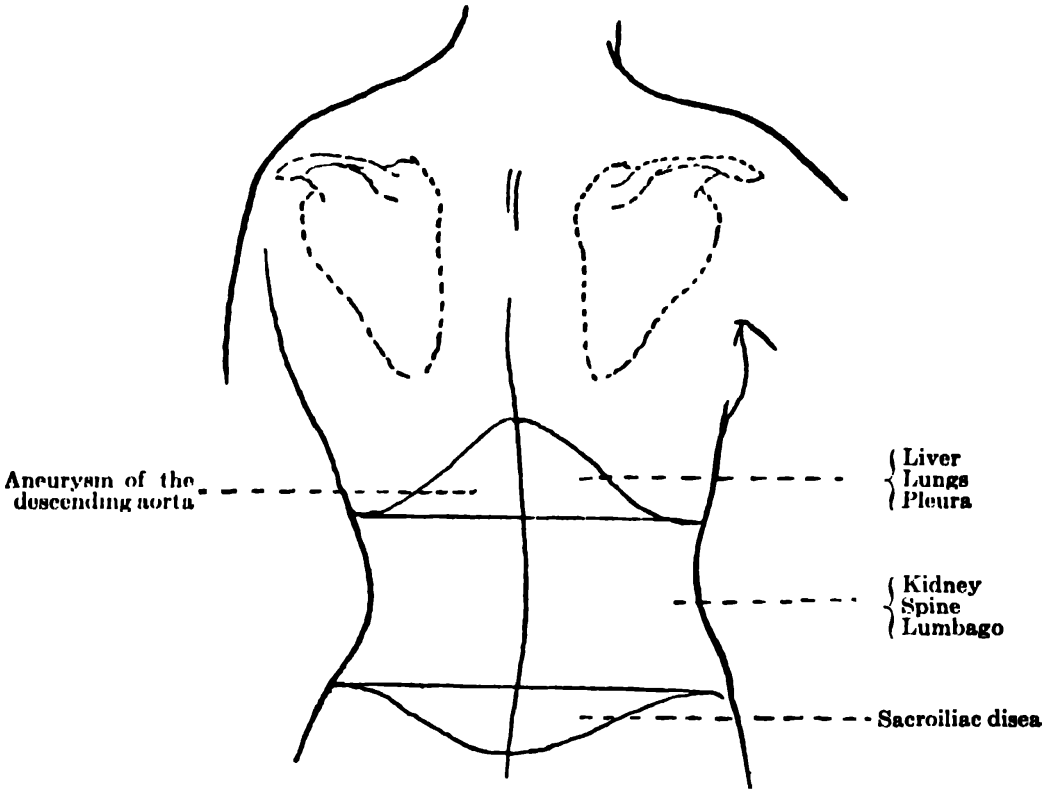


FIG. 84.—POSTERIOR VIEW OF ABDOMINAL ZONES.

In the annexed figure an attempt is made to outline the organs producing painful affections of each zone. In the upper zone, which is included between the diaphragm and the zonal line dividing the middle zone from the upper, two lateral zones are present at either side beneath the ribs. They are called the hypochondriac zones. Reference to the figures will show the organs giving rise to pain in each zone.

Lesions Causing Epigastric Pain.—In considering the regional localization of abdominal pain it is well to pay at least partial attention to the great variety of lesions to which pain in the epigastrium may be due; for, owing to the presence in the epigastrium of the solar-plexus, with its somatic peripheral distribution, pain in this region may be symptomatic of a lesion of almost any of the abdominal organs. The organs most frequently causing epigastric pain are:

(1) *The Stomach.*—The pain is very often associated with vomiting, and generally bears some relationship to the ingestion of food. It is found in acute gastritis, gastralgia, hemorrhage, ulcer, perforation, injury, carcinoma, and obstruction from any cause.

(2) *The Intestines.*—The pain is due to hemorrhage, rupture from ulcer or injury, obstruction accompanied by increase of peristalsis, and the formation of a tumor.

(3) *The Appendix.*- In all forms of acute appendicitis pain is present at first in the epigastrium, but quickly radiates to the right iliac fossa.

(4) *The Liver, Gall Bladder and Ducts.* In acute perihepatitis breathing is painful, and localized tenderness is present; biliary colic is often followed by jaundice; in cholecystitis the enlarged gall bladder can be felt, and chills and fever are generally present; in rupture of the gall bladder or of the ducts symptoms of peritonitis rapidly supervene; in carcinoma there are general signs of the disease, such as emaciation, and a positive hemolytic test. According to Riedel, ninety-seven per cent. of epigastric pains are due to gall-stones.

(5) *The Pancreas.*—In acute pancreatitis there generally is a history of previous gall-stone disease, with no cholecystitis, and no signs of a gastric lesion.

(6) *The Kidney.*—In renal colic, pyonephrosis and hydronephrosis there are urinary findings, such as blood or pus in the urine, to indicate the disease.

(7) *The Spleen.*—Splenitis, or traumatic rupture, may cause epigastric pain.

(8) *Ectopic Pregnancy.*—Rupture of an ectopic pregnancy sometimes causes epigastric pain.

(9) *Locomotor Ataxia.*—Locomotor ataxia causes a pain which may be referred to the epigastrium. There are also present

other signs of the disease, such as Romberg incoördination and Argyll-Robertson pupil.

(10) *Pneumonia.*—In pneumonia there are signs of lung consolidation.

(11) *Pelvic Lesions.*—Embolism of either the superior or the inferior mesenteric artery may be present, and produce epigastric pain with all the symptoms of bowel obstruction, but of much greater severity; in these cases some other grave disease, from which the clot obstructing the vessel is derived, is also present.

(12) *Adhesions* between any of the organs underlying the seat of pain may also be the cause of pain.

Character of the Epigastric Pain. If the pain in the epigastrium is sudden and severe, and does not follow a straining effort, examination should be made for:

(1) Appendicitis, which, if present, finally causes the pain to become localized in the appendix area. Typhoid fever, which in some cases, when it is of sudden onset, commences as a severe abdominal pain, and has often been mistaken for appendicitis.

(2) Cholecystitis, in which the pain finally becomes localized to the right hypochondrium.

(3) Acute hemorrhagic pancreatitis, in which the pain remains in the epigastrium.

(4) Perforating ulcer, in which the pain remains where it first appeared for but a very short time, and soon, because of the development of peritonitis, becomes generalized; or, in some cases, owing to extension of the exudate may at first be most severely felt in the pelvis.

(5) In obstructed intestines the pain, as a rule, has a tendency to ascend toward the ensiform, until tympany becomes excessive, when it is felt over the entire abdomen.

(6) In perforated gall-bladder the pain remains in the region of the gall-bladder, or passes down to the appendiceal region, until generalized peritonitis develops, when the pain becomes diffused over the entire abdomen.

Sudden abdominal pain, following a straining effort and not, confined to the epigastrium, may be due to: (*a*) hernial strangulation; (*b*) ruptured extrauterine pregnancy; (*c*) ruptured appendix; (*d*) tearing of peritoneal adhesions; (*e*) rupture of a cystic tumor; (*f*) twisting of an ovarian tumor or cyst on its pedicle.

As they will not be extensively considered elsewhere, a little time will be devoted here to cysts in which the pain is of sudden onset, very severe, and paroxysmal, sometimes continuous. The cause of the pain is torsion of the pedicle (ovarian cyst or tumor). This causes an extravasation of blood into the tumor substance and a consequent rise of internal cystic or tumor pressure with tension and traction on the capsule. Such an increase is especially apt to occur when the return circulation through the veins is obstructed. Should the capsule be lax, and the capacity of the tumor great, the pain from extravasation may not be great, even though symptoms of hemorrhage may supervene. Should the torsion occur in the pedicle of a wandering spleen or of a prolapsed kidney, the pain may be due to a beginning necrosis of the tissue, although it would seem more logical to define the increased intracapsular tension as being the active and potent cause. Pain, while of the greatest use in the diagnosis of twisted pedicle, is not of paramount importance. Richardson says that "a history of tumor, a sudden enlargement and tenderness in that tumor, preceded or accompanied by pain, are sufficient to make the diagnosis of twisted pedicle."

If the abdominal pain is due to irritation of the sympathetic fibers, it is present at first, as a rule, in the central part of the abdomen and later becomes localized more definitely to the area associated with the diseased organ or organs. On the contrary, if the cerebrospinal nerves are involved, from the development of a peritonitis, the pain is localized directly over the affected viscera. Bed clothing cannot be tolerated, and the abdominal muscles are rigid. The rigidity of the abdominal muscles over the diseased area is the result of somatic muscular reflex contraction. Hyperesthesia of the skin over the affected viscera is also present. This sensitiveness is generally not so sharply delimited as is the reflex tenderness from visceral disease. It is most severe at the site of the most severe inflammatory reaction, and diminishes concentrically from this point.

Sudden abdominal pain is diffuse, or is localized in the umbilical region (where the solar-plexus, the so-called abdominal brain, the sensorium of the abdominal viscera, is located). This pain may be associated with shock and collapse, which, when present, are fairly certain indicators of a severe abdominal lesion. In the condition of shock the associated symptoms of importance are a rapid pulse, obliteration of the liver dullness (look for rupture of a viscus), and rigidity of the abdominal musculature.[1]

Should the pain result from rapid and extensive extravasations of septic material, it is sharp, sudden and overwhelming. It is often ushered in by a feeling as though something had given way. At first it is continuous, violent, and almost unbearable; later it becomes paroxysmal and intermittent, or is dull and continuous. The pain, which at first is localized sharply in the region of the extravasation, becomes generalized as the septic material spreads throughout the abdominal cavity. When the peritonitis becomes diffused and the bowel distention is excessive, pain usually subsides, and when it does so, it is a sign of grave significance (Richardson).

Pain Due to Functional Processes.—When abdominal pain occurs, inquiry should be made concerning the following points:

(1) The relationship, if any, to the *ingestion of food.* If

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[1] Lennander explains the diffuse abdominal pain present in the early stages of so many infectious processes in the abdominal cavity as being due to:

(1) An increased sensitiveness of a large portion of the parietal peritoneum, owing to lymphangitis or peritonitis.

(2) A considerable increase and irregularity of peristaltic action, which, in addition to pain, often produces a feeling of sickness and vomiting, and leads to one or more actions of the bowels at the commencement of these illnesses.

(3) On account of increased sensitiveness, the movements of the stomach and intestines against the parietal peritoneum, and the stretching of their respective mesenteries, are felt as severe pains.

(4) In most cases, however, the general peritoneal irritation soon passes away; only the part more especially infected remains in a condition of inflammation, and the abdominal pain becomes localized at this spot.

there is any such relationship examine (a) the stomach and intestine for a gastric or duodenal ulcer, or for adhesions, or the intestine for a volvulus or obstruction, in which case the pain, at first, is periodic and paroxysmal, and, later, continuous and of an aching, dragging character. If the pain is sudden and intense, especially if it commences in the umbilical region and gradually becomes localized to the right side, examine for appendicitis. If the pain is continuous and increasing, it indicates that the local peritonitis is spreading. This is especially the case should there be a synchronous increase in the tenderness. (b) In pancreatic disease it may indicate a rupture of the duct or an acute hemorrhage and inflammation. (c) Biliary disease, as a rule, causes a pain which comes on about the first or third hour after eating, at the time of the greatest intestinal activity, and is especially marked when pericystic adhesions are present.

(2) Relationship of pain to *defecation* indicates: (a) hemorrhoids, which generally are associated with bleeding; (b) fissures of the anus, which often are associated with itching; (c) carcinoma of the rectum, in which bleeding is very marked and sometimes is present previous to the onset of pain; (d) ulcerations of the rectum, which, as a rule, are not painful, unless the sphincter region is involved.

(3) If the pain occurs in conjunction with *menstruation*, the genital organs should be examined, the uterus, tubes and ovaries all being subjected to a close inspection. If they are affected, the pain, because of the congestion then present, becomes worse during the menstrual period. Sudden abdominal pain is often premonitory of a miscarriage.

Pain Due to Intestinal Diseases.—A few facts worthy of attention are: That increased peristalsis of the bowel may, in case of *obstruction*, be a potent cause of abdominal pain. This pain is located across the middle of the abdomen; never below the umbilicus in obstruction of the small intestine, but generally above in lesions of the large intestine (Mackenzie). In obstruction of the large intestine painful states arise. These are the result of the obstruction to the forward peristalsis, and are called colics.

Of intestinal colics, there are those due to *acute indigestion*, in which the pain is usually accompanied by vomiting; those due to *poisoning as by lead or brass.* (These metals irritate and cause constriction of the blood vessels in the intestinal walls, thus indirectly irritating the sympathetic nerve filaments and causing muscular contraction and colic. Pal claims that in lead colic the blood pressure is increased from one-half to twice the normal, and that this increased pressure irritates the terminal filaments of the sympathetic, and thus causes pain); those due to *hernia,* which are generally accompanied by vomiting; those due to *uremia,* which may precede other uremic symptoms by a considerable interval (Musser); those due to *gall-stones,* which are probably the most frequent cause of colic (here the pain, as a rule, is located in the right epigastric zone, but may be felt in the right lumbar zone anterior); and lastly, those due to *renal calculus,* which are very severe, and sometimes are mistaken for intestinal obstruction, chiefly because of the intestinal distention and inability to move the bowels, a condition often the result of large doses of morphia which the patient has been given.

In children painful paroxysms frequently occur in the course of *purpura.* This disease, according to Guinon, is due to a toxic infective agent, with special action on the nervous system; so that it seems very probable that the colicky pains are due to intestinal cramps, the result of a deranged peristalsis, which in turn is the result of malactivity of the nervous system. The ordinary colics of children are accompanied by a great restlessness, throwing about of the body, and interrupted cries. Relief comes on the expulsion of flatus (Kerr, 861).

Perforation in typhoid is a cause of very severe and acute abdominal pain. In Manges' series of nineteen cases of typhoid perforation, abdominal pain was the first symptom to appear in fourteen. In two of them, however, it was accompanied by a chill, and in two others by vomiting. Though not the initial symptom, it was present in seventeen of the nineteen cases. One of the best descriptions of the pain due to typhoid perforation is that given by Selby. What he says applies to perforation of any hollow abdominal viscus. He says that abdominal pain is a most constant and reliable indication of perforation, depending, to be sure, on the mental condition of the patient and his appreciation of the sensation. The pain varies in degree, character and location. It may be so severe as to force a cry from a comatose patient, and, on the other hand, so mild as to attract but slight or no attention from a conscious patient. It may begin as a sudden, sharp, stabbing and agonizing sensation, or may come on gradually. Its duration varies also. It is usually circumscribed and is located in the lower part of the abdomen near to the median line, or towards the right side, and, generally speaking, the more circumscribed it is, the more keenly it is appreciated. Occasionally it is referred to the umbilicus and other parts of the abdomen, and even to the penis. If it be general at the start, as it sometimes is, it may, in the course of a short time, become confined to the lower part of the abdomen. On the contrary, if primarily it is localized, and later becomes generalized, it strongly suggests progressive peritoneal infection. The value of pain, however, as a symptom, lies not so much in its limits, its severity, the manner of its appearance, and its persistence, as in the fact that it itself is present. Its modifying features, when present, may be weighed in proportion to their degree, but when absent may be ignored in arriving at a diagnosis.

In one case of typhoidal perforation there was sudden pain in the lower abdomen, causing the patient to cry aloud; soon afterward there was intense pain in the penis (Allaben). The relation of this penis pain to the perforation is difficult to determine.

Abdominal pain may be caused by *adhesions*, for a discussion of which, see under Peritonitis.

Abdominal Tenderness. Tenderness on pressure, being closely allied to pain, may be considered in the light of a less-marked manifestation of that sensation. It usually accompanies pain, and not infrequently is present when actual pain is absent. It is found within the same areas as is the associated pain, but is confined within more narrow limits. Thus, diffuse pain is occasionally associated with a localized tenderness. This feature renders tenderness of value in the determination of the approximate location of the lesion. However, as such, it is not without fallacy. A widening of the tender area may be taken as an indication of a spreading peritonitis, and, as such, is an indicator of greater reliability than an increasing diffusion of the pain. "The value of tenderness as a symptom is enhanced, needless to say, by its characterizing features, but, as is true of pain, its real value lies in its mere presence."

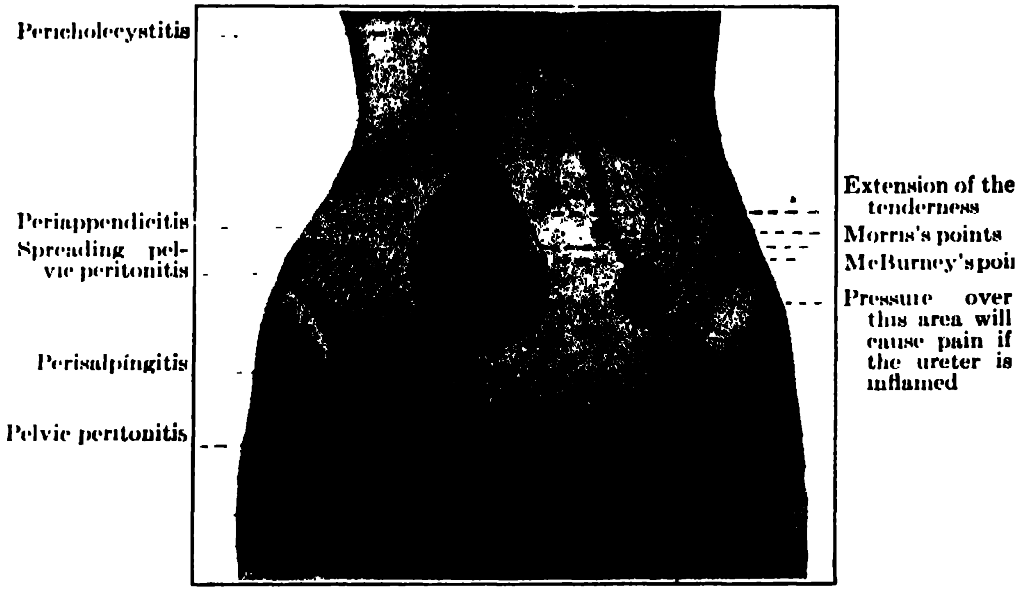
Pericholecystitis
Periappendicitis
Spreading pelvic peritonitis
Perisalpingitis
Pelvic peritonitis
Extension of the tenderness
Morris's points
McBurney's poi
Pressure over this area will cause pain if the ureter is inflamed

FIG. 85.—AREAS OF LOCAL TENDERNESS, WHEN THE INFLAMMATION OF THE APPENDIX, GALL BLADDER, AND FALLOPIAN TUBE AND OVARY HAS SPREAD TO THE PERITONEUM AND HAS PRODUCED A LOCALIZED PERITONITIS.

Morris's points are also shown, as well as the area in which pressure is made best over an inflamed ureter.

When abdominal pain is present, tenderness should always be sought over the areas associated with the gall-bladder, the pylorus, the appendix, and the hernial openings. Abdominal tenderness is sometimes due to a *hypersensitiveness of the abdominal musculature*, such as is produced by prolonged coughing. This tenderness is generally in the epigastrium in the region of the recti muscles.

Percussion is of value in determining abdominal tenderness. It often happens that, in percussing the abdomen, attention is drawn to a particular region by the wincing and involuntary shrinking of the patient from the percussing finger. This always indicates tenderness. After the attention is drawn to a particular area of the abdomen, more refined means of defining the degree and extent of tenderness (palpation and pin-prick pressure) may be used. Such measures have been described in earlier chapters.

Types of Tenderness.—Tenderness is of two types: temporary and permanent. Tenderness which is present *temporarily* over an organ may be due to the distention of the organs (stomach or intestines) with air or gas. As soon as the distention is relieved pain and tenderness cease. *Chronic tenderness* is more likely to be caused by inflammatory changes, especially in those in whom the abdominal wall or the parietal peritoneum is involved. Should the tenderness be superficial, and so acute that even the lightest pressure causes pain, it is probable that the condition is one of superficial neuralgia, such as is common during infectious diseases. On the other hand, deep tenderness is only of relative value, since even in many normal cases the forcing of the hand deep into the abdomen will cause pain.

Reflected Tenderness.—In the consideration of tenderness the fact must not be lost sight of that tenderness is not always present over the organ causing it; for in many cases pressure on or over the inflamed or diseased organ will cause pain at some distant area, and pressure over this area is painful, even though it is at a distance from and has no direct connection with the organs causing the pain. This is a most important point in the diagnosis of disease, and should never be forgotten.

A point of tenderness in cases of pelvic adhesions is given by Cumston, who says that "a symmetrical point of tenderness on the opposite side of the abdomen from McBurney's point will be found in pelvic adhesions."

This point of tenderness, as given by Cumston, closely approximates the point of tenderness defined by Morris as being present in pelvic lesions. Morris gives his point as being one and one-half inches from the navel on a line running from the navel to the umbilicus. He claims that when this point is tender on the right side alone, appendicitis is present, and that when it is tender on both sides, pelvic disease is present. This view has been controverted by Hubbard, who ascribes to these areas of tenderness, even in cases of chronic appendicitis, only secondary importance. McBurney's point, which is also a point of tenderness in appendicitis, is situated in the lower left quadrant of the right lumbar zone anteriorly, on a line drawn from the umbilicus to the anterior-superior spine of the ilium, and one and one-half inches from the anterior-superior spine. It has not the significance formerly ascribed to it (see Appendix).

POSTURE IN ABDOMINAL DIAGNOSIS

The posture of the patient, in cases of severe abdominal disease, is characteristic. The patient assumes two general positions: in the first, the posture of abdominal protection, the patient is alert, and while with one hand he attempts to ward off any abdominal interference (touch, palpation), with the other hand he covers (without making pressure) the painful area. In the second form the patient, instead of warding off abdominal pressure, seems to find relief when pressure is applied to the abdomen. He is, as a rule, doubled up, with the limbs flexed on the abdomen,

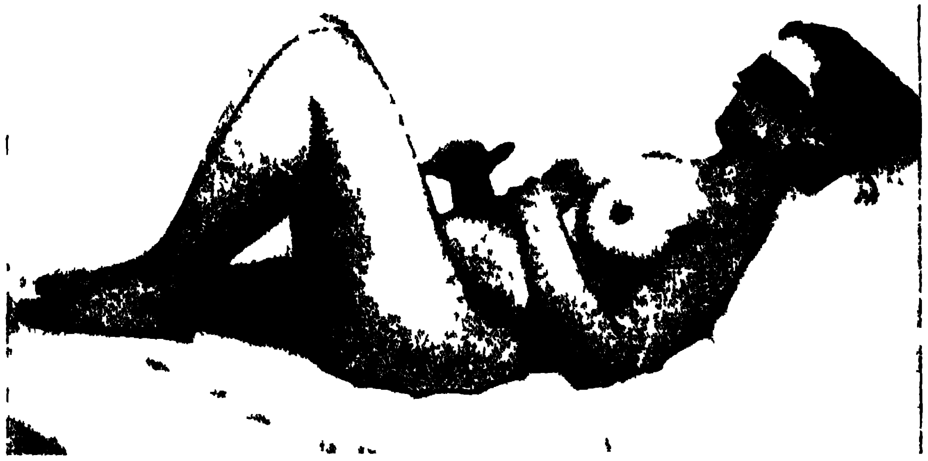

FIG. 86.—POSTURE OF ABDOMINAL PROTECTION PRESENT IN PERITONITIS. In cholecystitis and appendicitis, the hands may be the reverse of what they are in the figure the right hand acts as guard and the left as protector. In salpingitis, the protecting hand is over the lower abdomen.

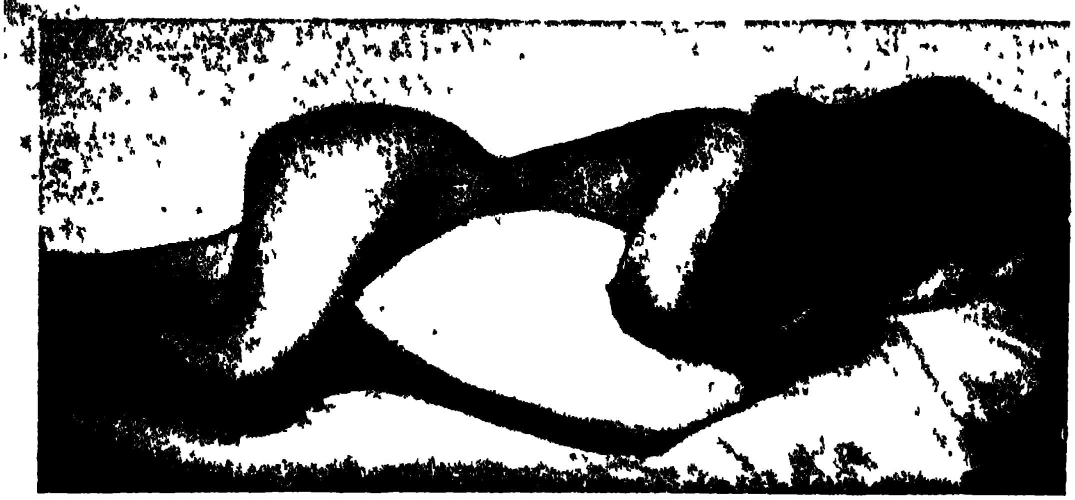

FIG. 87.—POSITION IN ABDOMINAL COLIC, ASSUMED ON LYING.

and the belly muscles tightly contracted. In some cases the patients make pressure on the abdomen with the hands, while in other cases they use for this purpose some other object (pillows, bolsters). In the first position inflammation of some of the abdominal organs is indicated, and if the sensitiveness is markedly increased peritonitis probably has already set in. The second position indicates some variety of colic, the paroxysms of which are indicated by the exaggeration of the position which the patient assumes when the pain comes on. The patient, as a rule, lies down, or, if this is impossible, assumes a sitting posture, with the arms folded and the body bent, so that pressure is made on the abdomen.

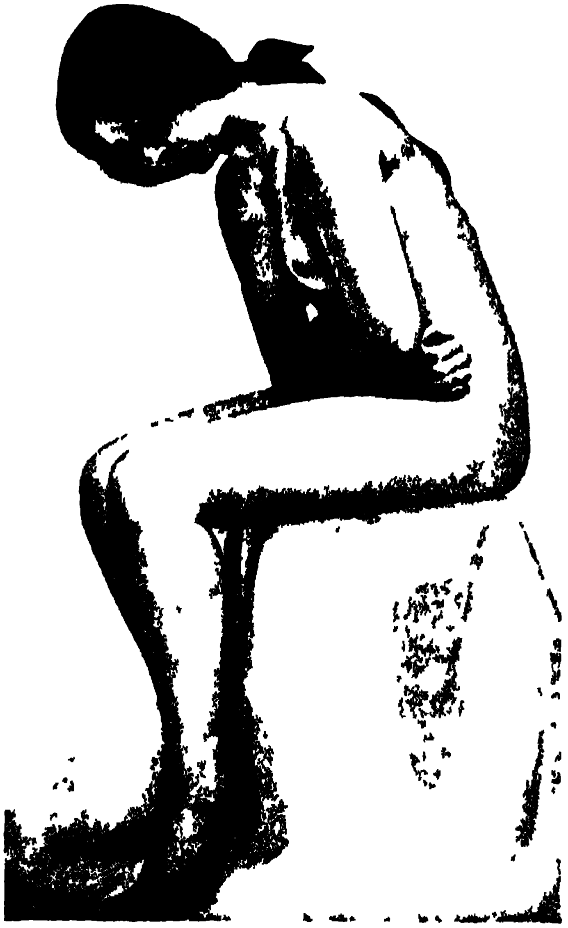

FIG. 88.—POSIT[illegible] IN ABDOMINAL COLIC, ASSUMED ON SITTING.

FORMS OF ABDOMINAL PAIN

To complete this chapter a brief discussion of some of the most common forms of abdominal pain is necessary. Among those most frequently encountered is renal colic, the pain of which is generally on the affected side, passes downward toward the pelvis, and is often very acutely felt in the testicle on the side of the disease. In the purpura of infants painful abdominal paroxysms are common (155). According to Musser, abdominal pain is often a precursor of uremia. This pain is usually situated in the right or left hypochondrium, and, when in the left hypochondrium, has been mistaken both for gastritis and gastric perforation. Enteroptosis, particularly gastroptosis, may produce pain in the suprapubic region (Deaver).

Keen reports a case of rupture of the rectus muscle, in which, at the time of the rupture, sudden, sharp pain was felt in the abdominal wall. Such a rupture may occur in a typhoid patient who is convalescing, and generally follows some sudden exertion. The symptoms of rupture are sudden, sharp pain and tenderness localized to the point of rupture. The rupture is generally accompanied by vomiting. Examination shows a depression in the course of the muscular fibers, later accompanied by ecchymosis and swelling.

If the pain is in the rectum, it may be caused by a prolapsed colon.

Arteriosclerosis of the abdominal vessels also causes abdominal pain, which generally is severe and paroxysmal. For a full discussion, see under Arteriosclerosis of the Mesenteric Arteries.

A condition is described by Depage in which pain is due to a displacement of a rib. Examination will show that the eleventh and in some cases the tenth rib is projecting over the iliac crest. The pain is intermittent and is worse when the patient walks or moves about. Pressure over the ends of the tenth and eleventh ribs is painful, and pain is also experienced if the angles of the ribs are brought one over the other. The condition is most frequent on the right side.

A rather rare and frequently overlooked cause of abdominal pain is anemia (Musser, 5).

Functional Pains.—Richardson speaks of neuralgia of the abdominal organs as a cause of abdominal pain. This term, as a rule, is a misnomer, for nearly all cases of supposed abdominal neuralgia are due to some condition having a more definite pathologic basis than is found in neuralgia. The only reason that these lesions are not properly diagnosed is that the search for their pathology has not been sufficiently prolonged nor assiduously enough pursued. While neuralgia may and does occur as a cause of abdominal pain, it is much less frequent than is supposed.

The so-called functional pains are frequently classified as neuralgic, but in nearly all cases these pains can, by patient search, be shown to be due to organic lesions, sometimes obscure, but present nevertheless. Under functional pains, Richardson gives gastralgia, nephralgia, oophoralgia, and simple intestinal colic from gas. All except the last are recognized entities, but not in the same manner as is generally understood.

Gastralgia is only a term, usually applied to a painful state of the stomach, having an unknown basic cause. In some cases, when it is due to a painful condition of the muscular structure, it should be called gastromyalgia; on the other hand, if the nerves are affected, it should be termed gastroneuralgia. However, all painful conditions of the stomach, whatever the etiology, may be classed under the generic term gastralgia. So likewise painful states of the kidney and ovary may be called nephralgia and oöphoralgia. But often, alas, when we suffix "algia" to the name of an organ, it means that we are but adding a cloak to conceal our ignorance of the real cause of the pain which is present; it means that we are naming the diseased state from a symptom instead of from the pathology. The careless use of these terms cannot be too strongly condemned, and they would be seldom employed if it were borne in mind that they frequently are but the indicators of ignorance and sloth.

The presence of *abdominal pain in neurasthenics* should always be a subject of considerable investigation before a definite diagnosis is made. The neurasthenic is frequently subject to the delusion that there is something radically wrong in the abdomen, and even though operation and removal of an ovary or of an appendix may relieve the symptoms for a time, the pain soon returns, and is found in a new location, so that it is almost an impossibility to relieve this class of people, either with or without operation. Psychotherapy in the form of reëducation is probably at the present time the most efficient means at our command of producing relief.

After the review of pain, as given in the previous pages, it may be well to consider the *time of life* at which the different pains are most frequent. For this purpose, life may be divided into four periods: infancy, childhood, adult life and old age. Infancy, with its sensitive and helpless condition, offers a double hardship to the examiner, for he not only has to elicit symptoms, but has to derive them without the patient's help. For this reason, pain, as a symptom of disease in infancy, is a factor of almost negligible value. It becomes important only as the infant grows older, and, by intelligent coöperation, is able to tell the examiner something of the type and character of the pain which he experiences. Yet, with all these drawbacks, even in infancy pain is of some little value. When the infant continuously cries and cannot be hushed by its mother, as a rule, it is suffering from some form of pain. The most common causes of pain in infancy are colic, gastroenteritis, and intussusception. In children one should look for these conditions, and, in addition, spinal caries, gall-bladder disease, appendicitis and pneumonia. In adult life all of the above, with the addition of gall-stones, gastroduodenal ulcer, pancreatic disease, hernia strangulation, and, if the patient is a woman, ovarian, tubal or uterine disease may be present. As old age comes on, the tendency to malignant growths increases, and in case of persistent pain one should seek for cancers.

Care in Diagnosis.—As previously mentioned, tabes dorsalis, caries of the vertebræ and tumors of the spinal cord cause pain. These three conditions should always be thought of in those cases in which an abdominal pain is present without sufficient and definite cause. So often are they mistaken for disease of the intraabdominal organs that the physician must be very careful to exclude them before he arrives at any definite conclusion. Howell (111b) speaks of cases of tabes dorsalis being mistaken for cases of appendicitis and operated upon. Lead poisoning should also be sought; and when the patient with colic is a painter, the gums should be inspected at once, to ascertain if the blue line at the edge is present (Burton's blue line). In lead colic, the abdominal cutaneous hyperalgesia is absent (Robinson, 265).

Intercostal neuralgia causes pain which is referred to the anterior abdominal wall, and is likely to be mistaken for an intraabdominal lesion. The presence of the pain points is a differentiating symptom (see Neuralgia).

Pneumonia frequently refers its symptoms to the abdomen, and in some cases so strongly that an abdominal lesion has been diagnosed. In many cases appendicitis operations have been performed *with negative results* for appendicitis, and the operator, to his chagrin, has found pneumonia symptoms developing during the course of the next few days. All cases of acute abdominal pain, with rapid pulse, rapid respiration, and high fever, should at once direct the attention to the chest. The tenderness, also, is characteristic, in that in pneumonia the skin over the abdominal area in which pain is complained of is very tender, but deep pressure is well borne (Howell, Hood, Bennett). This is the opposite to the rule in severe abdominal diseases.

Pleurisy has also been mistaken for abdominal disease, and a case is cited by Bennett (144, p. 1005), in which operation would have been performed for appendicitis had it not been that a band of tenderness extending around the abdomen above the umbilicus drew attention to the pleural involvement.

Hilton claims that the abdominal pains of thoracic visceral disease are due to involvement of the parietal nerves, and a subsequent reference of the irritation to their distribution area. He says that the pleura is supplied by the intercostal nerves, an opinion which is disputed by Mackenzie. (See pleura.)

Abdominal pain may also occur with obstinate constipation.

DIAGNOSIS BETWEEN INFLAMMATION, NEURALGIA AND COLICKY PAIN IN ABDOMINAL REGION

Pain	Inflammation	Neuralgia	Colic
Type and radiation	Dull aching, and if the inflammation is acute and engorgement of the vessels is excessive, the pain has a throbbing character. The pain also tends to radiate from the inflamed area outward towards the periphery.	Sharp, acute, generally radiates along the course of a nerve, as in neuralgia of the tenth dorsal nerve, in which the pain radiates around from the tenth interspace to the area of distribution on the abdominal wall.	Sharp, acute and agonizing; the pain of a colic radiates in different directions depending upon the location of the colic; for instance, in gall-stone colic the pain radiates around to the back underneath the scapula of the same side.
Pressure..........	Increases the pain.	Is excessively tender. The slightest pressure produces an excruciating pain. Pain can also be produced by pressure upon the nerve trunks and this pain radiates along the terminal branches.	Eased by pressure: as in cases of gall-stone colic, the patient seeks ease by doubling up and making pressure against the abdominal wall.
Duration	Constant.	Intermits, but intermission is not sudden and acute.	Stops suddenly, but the soreness persists for a short time.
History......	Generally has not had a previous attack	May not have had previous attack.	Generally a history of previous attack.

When it does so occur, it may come on rather suddenly. It gradually increases with little or no increase in the temperature; finally vomiting of stercoraceous material occurs and the diagnosis is made clear.

CONDITIONS ASSOCIATED WITH ABDOMINAL PAIN

Spasm and Rigidity of Muscles.—*Spasm of the abdominal muscles* nearly always accompanies abdominal pain, especially if the pain is severe. This symptom is lacking in those who have very lax or atrophied abdominal walls, and it is also much less marked in women than in men, because their muscular development is generally much less than that of men. On the other hand, severe *rigidity* of the abdominal wall may, in those of a very muscular build, supervene upon a very slight intraabdominal irritation. Localized rigidity is a good indicator of the region of the abdomen involved, for the contraction generally takes place immediately over the diseased viscus. Should abdominal rigidity gradually become lessened, while the toxic state of the patient gradually increases, it indicates that the lesion, whatever its nature, is increasing in virulence, and is becoming dangerous to the patient. This is particularly so if the leukocytosis, which has been present, decreases to, or even below, the normal level. Spasm of the abdominal muscles is of diagnostic value in differentiating abdominal from pelvic lesions, it being marked in abdominal lesions, and almost, if not entirely, absent in pelvic lesions.

Visceromuscular Reflex.—In abdominal lesions, also, the so-called visceromuscular reflex (Mackenzie) may be present and render the diagnosis more difficult, especially since, in the abdominal parietes, the muscles have the power of segmental contraction over an area of inflammation or irritation. These segmental masses of muscles are very deceiving to the palpating hand, and have been mistaken by the examiner for: (1) enlarged ovaries, (2) an enlarged and inflamed appendix, (3) tumors, intraabdominal and parietal, (4) inflammatory exudates, and (5) intestinal tumors, due to volvulus, intussusception, etc.

During every abdominal examination, the possibility of confusing these reflex muscular contractions with tumors, etc., should always be borne in mind, and, since the rectus abdominis is mostly at fault, its nodal points should be carefully mapped out. One of these points occurs at the umbilicus and another between the umbilicus and the costal arch. Any swelling due to contraction of the rectus would occur between these points and would be somewhat oblong in shape.

In the diagnosis between these phantom and true abdominal tumors it is well to observe: (1) that a tumor may vary in its relative position to a fixed point (umbilicus) on the abdominal wall, but a contracted part of the rectus muscles does not so vary; and (2) that while the tumor, which is the result of contraction of the muscle, may be so persistent and constant that sometimes, even under chloroform, it yields with difficulty, yet it *always does yield;* while a tumor which is the result of organic disease is more clearly defined when, as a result of the anesthetic action of chloroform, relaxation of the rectus muscle occurs.

Toxemia also has a restrictive action on pain perception, and if it is pronounced, abdominal pain is perceived very slightly, or not at all. As Musser remarks, when a hyperleukocytosis is present, with associated severe toxic symptoms, even though pain is absent, a serious lesion should be considered.

Indicanuria, as an accompaniment of pain, is of considerable value in localizing the lesion to the small bowel.

Polyuria.—Many painful conditions of the abdomen are associated with polyuria, and Osler has remarked on the frequency of polyuria in the later stages of typhoid fever.

Relationship of Hysterical to Abdominal Pain.—Hysteria as a cause of abdominal pain is only mentioned to be condemned. It seems to be a term with which many clinicians hide their ignorance and diagnostic distress. The more a physician sees of abdominal pain, and the more frequently he follows his case to operation or to autopsy, the less seldom he makes a diagnosis of hysteria. It seems that nearly all so-called abdominal pains of hysteric origin have for their basis something more than a disordered nervous system. Under the shadow of this name are hidden many cases of gall-stones, appendicitis and gastric ulcer. Many are the patients who go on to chronic invalidism or lie in too early graves because of the ignorance or inattention of their physicians to these facts.

Abdominal incisions are frequent causes of abdominal pain. Since this is of vital importance to the surgeon, I quote from Maylard, who, to avoid pain as a result of abdominal incisions, recommends that the "incision be made in the most favorable part of the abdomen; that is, the part that has the fewest nerves, and that, during the operation, as little irritation or destruction as possible to the tissues of the wound be made."

Post-operative abdominal pain, according to Maylard, is caused by irritation of the nerve endings. If it follows immediately after operation, it is due either to tight suturing or to the pressure exerted by encircling ligatures. Tension is generally indicated by a throbbing pain or ache. When the pain is due to tight suturing or to the ligatures, it follows almost immediately upon the operation, and generally is of a stinging, stabbing character. In some cases a nerve may be transfixed with a suture or ligature, and be a constant source of pain production. If the pain follows twenty-four to forty-eight hours after operation, it is due to inflammation, with consequent swelling and pressure. When the inflammation is mild, little or no pain results; but should it be so extensive that exudation is present, the pressure from the exudate upon the terminal nerve filaments is productive of pain, in some cases very severe. The distress which at first was intermittent is now continuous, and should a rise of temperature occur suppuration will generally be found to be present. Inflammation of the skin or subcutaneous tissues generally produces pain in the first twenty-four to forty-eight hours, while inflammation of the deeper structures does not produce discomfort for longer periods. In case the inflammation is of the peritoneum or subperitoneal tissues, discomfort and pain do not make their appearance until about the eighth day after operation. If the patient is very obese, a considerable amount of effusion takes place into the wound, and, as

Maylard remarks, unless drainage is provided, tension, inflammation, and consequent pain will follow.

Pain Referred to Extraabdominal Regions.—In disease of abdominal organs the pain is sometimes referred to an extraabdominal location. For instance, it is common to have *pain in the shoulder* in diseases of certain abdominal viscera. This pain has been described as due to irritation of the phrenic nerves, which convey the stimulus to the roots of the cervical nerves, to whose cutaneous distribution the pain seems to be referred. This pain, along with an area of hyperesthesia of the skin of the shoulder in lung inflammation, has been attributed to diaphragmatic irritation by Mackenzie, although he also suggests that it may be due to the vagus terminations being involved. It is probable that the shoulder pain, which is found associated with gall-stone and gall-bladder disease, is due to involvement of the diaphragm in the inflammatory process. Likewise, in certain cases of rupture of extrauterine pregnancy, we find that pain is present in this area. In these cases the pain may be due to pressure upon the diaphragm by the accumulation of extravasated blood (for it is a peculiar fact that, on standing, the pain often disappears).

Absence of Pain.—Should abdominal pain be absent when naturally it should be expected, or if it should disappear before the natural termination of the disease would warrant its cessation, the patient should be examined for: (1) perforation of the viscus involved, (2) gangrene of the diseased organ, and (3) increase of toxemia to such an extent that the patient's faculties are dulled so that he is unable to perceive pain.

When *perforation of a viscus occurs*, pain is temporarily relieved; but the relief is due only to the incapability of perception which accompanies the shock produced by this condition. When perforation takes place the pulse generally increases in rapidity and becomes weak and thready. The temperature first falls and then rises, as infection and a generalized peritonitis ensue. Any localized tenderness which may have been present before the perforation now becomes diffused, and muscular rigidity, which before was restricted to one area, now becomes general. Should *gangrene* of an abdominal viscus occur, the temperature, because of consequent toxemia, may fall. That this fall is not beneficent, may be seen from the pulse, which is constantly increasing in rapidity, and from the increasing stupor and somnolence of the patient, whose appearance indicates that he is suffering from a most severe disorder. The disappearance of the pain as an indicator of improvement is of value only if all associated symptoms improve concomitantly with it. In many, though not all cases, the rapid disappearance of the cutaneous hyperalgesia occurs simultaneously with the onset of gangrene (Bennett, 112, p. 1005). Toxemia can be easily diagnosed by the increasing stupor and coma associated with it. However, even in the most advanced stages of stupor and coma, while the patient does not complain or cry out from pain, a close examination will disclose the facial expression of the most severe distress.

CHAPTER XXII

PAINS OF THE ALIMENTARY TRACT

Lips.—It is very rare for the lips to be afflicted with pain without noticeable organic change, although sometimes neuralgia of either the second or third branch of the fifth nerve seems to be particularly confined to either the upper or the lower lip. In this case we find that the lips are normal in appearance but exceedingly tender to pressure. The pain also comes in paroxysms, between which there is no pain and absolutely no tenderness. The principal organic changes in the lips producing pain are inflammation and fissure. Inflammation of the lips is generally due to infection, which has entered either through an abrasion or a pustule. When it is present there is considerable swelling, and the pain is of a constant, throbbing character. The involved area is very tender to the touch, and motion is almost if not entirely abolished, so that it is very difficult to take food. When fissures are present linear abrasions may be seen running across the mucous membrane of the lip, and at the angles of the mouth, where they are very common. Opening the mouth is very painful, and the contact of the denuded surface with salty or acid substances is also very disagreeable, so that the patient is averse to eating.

Herpes of the lips is very common in the early stages of infectious diseases, and, as a rule, the vesicles are exquisitely tender. Herpes of the lips is frequently complicated by infection.

Cheeks.—Pain in the cheeks may be due to inflammation or to neuralgia. Inflammation is generally not of local origin, but is the result of an extension from adjacent areas, such as the gums, or alveolar processes. When it is present the cheeks are kept at rest. They feel as though they were stiffened, and are hard and board-like. There are also considerable swelling and a glossy appearance of the skin. Neuralgia (trigeminal) here is not different from neuralgia in other locations, and gives rise to the same signs and symptoms. A condition of the cheeks that is very painful is a vesicular formation on the internal mucous membrane surface. This is very disagreeable and, though it does not cause any subjective pain, the least irritation, such as the rubbing against it of the tongue, or of solid or liquid food, causes a very disagreeable sensation. These vesicles are either the result of nerve involvement, such as is found in trigeminal herpes, or are but the reflex herpetic eruptions of digestive disturbances. If on the tongue an ulcer that is free or almost free from pain is found, syphilis or tuberculosis should be sought. In mild inflammations, such as those which accompany stomatitis, there is moderate pain, which is increased on the ingestion of food. At the same time there are thick, sticky saliva, impaired taste, and often a slight rise of temperature.

Teeth.– Sometimes, in cases of toothache, the aching may be due to hyperesthesia, a common accompaniment of pregnancy. Ordinary toothache is due to an irritation of one of the branches of the trigeminus by products of dental caries. At first the pain is more or less localized to the point of origin, but it gradually may become so accentuated that a general neuralgia results, and the entire side of the face may become affected. This may increase until the entire side of the head and neck is tender and painful. This extension can be explained by the rich collateral association of the trigeminus with the cervical nerves. Because of this close relationship it is easy to understand how an excessive stimulation of one nerve can produce reactions in adjacent nerves. In some cases, after the extraction of teeth, pain may persist for several days, especially if gum-boils are present before the extraction, in which case the pain may persist for five or six days (Vosper, 896).

The most sensitive part of a tooth is the pulp and the agents causing the greatest reaction are heat and cold. Head claims that, until the pulp is involved, the pain remains local, but as soon as it is affected the local is changed into referred pain. Thus, in the course of destruction of a tooth three different varieties of pain are encountered:

(1) The local, sharp pain, associated with destruction of the enamel and involvement of the dentine. It is easily produced by the sensitive dentine coming into contact with very hot or cold substances, drinks, etc.

(2) The referred pain from involvement of the pulp cavity. It seems that each tooth has a separate area of pain reference; for instance:

TOOTH	REFERENCE AREA
Upper Jaw	
(1) Incisors	Frontonasal region
(2) Canine	Nasolabial region
(3) First bicuspid	Nasolabial region
(4) Second bicuspid	Temporal or maxillary
(5) First molar	Maxillary region
(6) Second molar	Mandibular region
(7) Third molar	Mandibular region
Lower Jaw	
(8) Incisors	Mental
(9) Canine	Mental
(10) Bicuspid	Mental
(11) Second bicuspid	Hyoid or mental
(12) First molars	Hyoid—also in ear and just behind angle of the jaw. The tip of the tongue on the same side is also tender.
(13) Second molars	
(14) Lower wisdom	Superior laryngeal area

(3) After the pulp is destroyed the referred pains cease and there are only local pains, due to involvement of the periodontal structures. For more detailed information, see Head, Brain, 1904, pp. 406-415.

Central trigeminus pain (tic douloureux), either from involvement of the ganglion itself or its internal roots, or as a result of pressure (cerebello-pontine angle tumor, neuroma), often leads to a faulty diagnosis of teeth pains. Many patients suffer the loss of one tooth after another in the vain search for the affected one. After the sacrifice of the teeth the dentist or physician wakes up to the fact that the disorder is central, and that a grave mistake has been made.

Tongue.—The lesions of the tongue which are apt to give rise to pain are inflammation, fissures, ulcers, new growths, and vesicles. Inflammation can generally be traced to some abrasion or injury, or to an extension of inflammation from some adjacent area; however, there is a unilateral inflammation (hemiglossitis) which is probably of neurotic origin. Fissures in the tongue, as in all sensitive mucous membranes, are apt to be very painful, because of the exposure of the sensory terminal filaments. This is also true of ulcers, which in this location likewise are very painful. New growths in the tongue give rise to a sensation of discomfort rather than to one of pain. Vesicles due to herpetic disturbances may appear on the tongue, and when they do, they cause great distress owing to their extreme sensitiveness. They generally are an indication of a central lesion, *central herpes*, though they may be, as are similar vesicles on the cheek, but a manifestation of disturbed digestion (reflex herpes). When due to herpes the vesicles generally appear on the posterior half of the tongue, which derives its sensory supply from the glossopharyngeal nerve. Tuberculosis and syphilis of the tongue are not painful unless there is a breaking down of the lingual tissues, with a consequent exposure of the sensory nerve filaments.

In many cases a hyperalgesia of the tongue is an indication of hysteria, which, when present, generally gives rise also to parageusia or gustatory paresthesia (disturbances of the sense of taste), the patient complaining either of the disagreeable taste of that which would otherwise be agreeable, or of the persistence of a bitter or of a sweet taste in the mouth when nothing has been tasted. This is a fairly frequent condition in neurotics, particularly those suffering from neurasthenia.

The presence of small, painful lesions of the tongue may be the first indication of a nocturnal epileptic attack.

There is an extremely painful condition of the tongue, due to a papillitis, in which nothing abnormal can be found on the surface; but, on magnification, small, ulcerating points are seen hidden in the folds of the mucosa about the fungiform papillæ of the tip and the margin of the tongue.

Moeller's glossitis, or chronic superficial glossitis, is characterized by bright red lines or patches at the margin or tip. The pain, which is the principal lesion, is out of all proportion to the local involvement, and is much increased in chewing and speaking.

According to Riesman (113b), pain in the tongue (glossodynia) which arises without any apparent organic lesion, may be divided into the following, which is the classification of Chaveau (112b).

(1) Glossodynia secondary to trigeminal neuralgia, especially the inferior dental branch of the trigeminal.

(2) Glossodynia of the insane, starting as a local paresthesia.

(3) Glossodynia of tabes, corresponding to crisis in other organs.

(4) Glossodynia of hysteria.

(5) Rheumatism of the lingual muscles, or rheumatic glossodynia.

(6) Glossodynia due to local causes. These may be classified into the extrinsic and intrinsic. The *extrinsic causes* are: (*a*) dental affections and artificial teeth, and (*b*) granular pharyngitis and hypertrophy of the posterior pillars and of the lingual tonsil. Among the *intrinsic causes* are: (*a*) lingual varices; (*b*) chronic glossitis from tobacco, alcohol, spices, iodin, lead or gout, and (*c*) papillary hypertrophy of the follicular region of the tongue.

Reference Areas in Diseases of the Tongue.—Disease of the anterior portion causes pain to be referred to the mental area; of the lateral portion, to the hyoid area; of the dorsum, to the superior laryngeal and the occipital area (Head).

Salivary Glands.—The salivary glands are subject to the ordiliary glandular pain-producing diseases, as inflammation, etc. There may be present also, in the ducts of the glands, some obstruction which gives rise to an intermittent colic with an associated swelling and tumefaction of the gland. This condition may sometimes be diagnosed by running the finger along the course of the ducts, when an obstruction, if present, generally may be felt. The most common form of obstruction is a salivary calculus (Ranulus). The parotid gland sometimes becomes inflamed, and is very painful, giving rise to the entity called "mumps." It also becomes tender after oophorectomy, and in some cases where orchitis is present. Pain beneath the angle of the jaws, in those who are convalescent from typhoid, should always lead to investigation of the parotid as the possible cause of the pain.

Pharynx and Tonsils.—Pain in the pharynx may be present, either objectively, on swallowing, or subjectively, without any provocative act. In the first case we find that the causative factors are slight, such as small ulcers and superficial inflammations; but when the infectious agents extend deeper, and the surrounding connective tissues are involved, the pain is felt without any exciting productive factor, and is continuous. This is well exemplified in parenchymatous tonsillitis, in which the pain extends to the angles of the jaws, also to the ears, even down the neck, and in phlegmonous pharyngitis, which is extremely painful, there being a constant burning or aching pain, which in some cases assumes a throbbing character. In the latter, the pain may be of such magnitude that the patient lives a miserable existence, being unable to eat or to sleep until the abscess which has formed ruptures and relieves the pressure.

The tonsils and posterior pharyngeal wall may be extremely tender in certain forms of streptococcic sore throat, and the pain often persists for a long period after the cessation of the acute inflammation.

A so-called gouty throat causes a similar painful condition of the pharynx and tonsils. There are few signs of inflammation; the mucous membrane, however, is lax and edematous.

Various types of pharyngitis, granular, follicular, etc., cause pain. The diagnosis depends upon a special knowledge of the various pictures. All of these conditions cause a certain amount of referred pain. The pain in front of the ear, complained of so much by patients with tonsillar affections, or by those who have some tonsillar traumatism, operative or otherwise, is in the hyoid reference area of Head (for which, see Fig. 60, p. 291). The pain may also be referred to an area in the neck in the submaxillary triangle. Palpation here will disclose an enlarged gland.

Esophagus.—The esophagus below the cricoid cartilage was formerly considered to be non-responsive to tactile and other stimuli, but now it is known to be sensitive to heat, cold, tactile and chemical stimuli, and it is also held that many apparent stomach sensibilities are, in reality, esophageal sensibilities. Inflammation of the esophagus is, if severe, productive of considerable pain. The pain is of a deep, burning character, and is felt along the course of the esophagus. Pain is also felt on movement of the esophagus, which occurs when the head is bent forward or backward, and is also present when external pressure is made through the overlying tissues upon the esophagus. Pain on swallowing is very severe. In the severest cases of corrosive esophagitis there may be no pain.

Pain felt in the esophagus, without any objective lesion, may be due either to a hyperesthesia or a paresthesia. In the former, pain is produced by factors which cause irritation, such as inflammation of the esophagus, or a neuritis of the nerves supplying it. The latter (neuritis) gives rise to a perversion of sensation; for instance, the act of swallowing, which ordinarily gives rise to no sensation, is, in this condition, interpreted as painful. In stenosis of the esophagus pain, as a rule, is absent. In cancer of the esophagus there may be only a feeling of distress or of discomfort under the sternum, generally localized to the area of the growth. Sometimes severe pains, confined to the area of the growth, or referred to the region of the xiphoid cartilage, may also be present. They generally are of a "tearing, piercing character, and radiate widely to the back, neck, or shoulders." They accompany the deglutition of food, but may be independent of it, and are often nocturnal. Though generally present only late in the disease they may be the earliest manifestations of it (McCrae).

Referred pains may be present in the intercostal spaces between the shoulder blades, in the epigastrium, in the throat and head, in the ear, or in the extremities (Rosenheim).

Dyspnœa and attacks of pain resembling angina pectoris also occur. These are due to pressure on the trachea or upon both recurrent laryngeal nerves.

Localization within the esophagus is fairly accurate. Lamy, in his study of one hundred and thirty-four cases of carcinoma of the esophagus, found that four-fifths of the patients were able to locate the lesion within an inch or two of the correct site; but in the remainder a correct localization was impossible; often a carcinoma of the lower third would be located by the pain-sensations in the upper third, or *vice versa*. Obstruction gives rise to sensations for the most part in the middle line, deeply seated, beneath the sternum, or, if the obstruction is low down, in the epigastrium.

CHAPTER XXIII

THE STOMACH

After the review of the pain producing diseases which are located in the alimentary passages leading to the stomach, it is next in order to consider the pains and pain-producing disorders of the stomach. Of late years there has been considerable controversy as to whether the stomach has pain-sensation or not. The weight of the argument seems to be on the side of those who claim that it has not. It is claimed that the sensations which are felt in disease of the alimentary viscera are but referred sensations or impulses, carried to the cord in the sympathetic pathways, and thence referred again to the periphery through the cerebrospinal nerves.

From the researches of Hertz in particular it would appear that the gastric mucosa does not respond to tactile nor to chemical stimuli by pain. The stomach mucosa does not register thermal stimuli, and the sense of warmth and coolness following the ingestion of hot or cold liquids is largely due to the sensibility of the esophagus to these forms of stimuli. The sensation of fulness in the stomach is due to the deep-pressure sensibility of the muscular coat, and is brought about by tension.

The sensation of hunger and emptiness is largely a matter of habit, associated with malaise and weakness. It is conditioned by the disturbance in the periodicity of the muscular hypertonus and of neuronic excitability, normally the result of regular eating.[1]

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[1] According to W B Cannon and A L. Washburn (*Amer. Jour. of Physiology*, March, 1912, Vol XXIX, p 455), hunger is due to the contraction not only of the stomach, but also of the lower part of the esophagus and the intestines They were able to prove a relationship between rhythmic contractions of these organs and pain sensations.

However, even though pain in the stomach is not, as a rule, regarded as true visceral pain, yet it is closely related to it, for it may be due to the tension already spoken of or to the spread of the disease to surrounding sensitive structures, or to the traction of the peritoneal connections. The accompanying tenderness is most often due to hyperalgesia of the skin, voluntary muscles and connective tissues supplied by that segment of the spinal cord which receives the incoming stimuli from the stomach itself and its contiguous structures.

AREAS OF REFERRED PAIN CAUSED BY STOMACH DISORDERS

The areas to which the pain of stomach disorders are referred are, first, the epigastrium, and (in many cases) the back, in an area which, according to Cumston and Maylard, is between the posterior borders of both scapulæ and opposite the spinous process of the *fifth dorsal vertebra*. The pain also often circles around from one of these areas to the other, and they are often tender to the touch. The area spoken of by Cumston and Maylard as opposite the fifth dorsal spine is given by other authorities as opposite the ninth or tenth dorsal spine. This agrees with

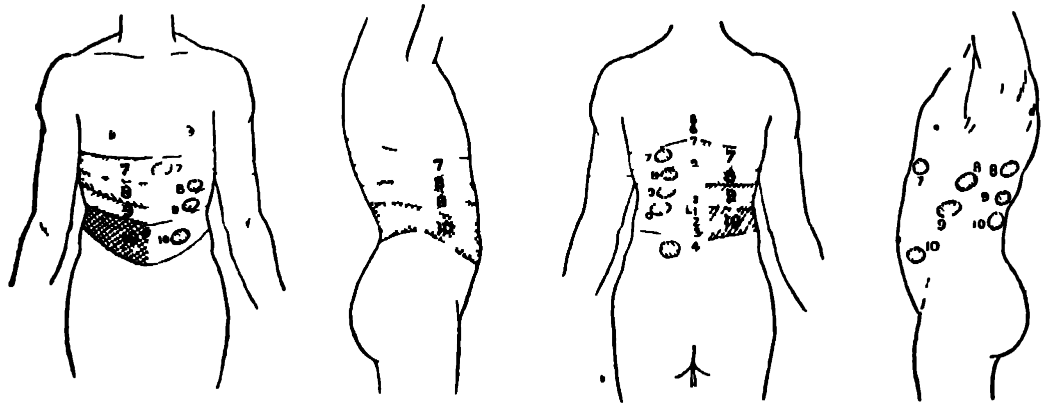

FIG. 89.—AREAS OF REFERRED PAIN AS GIVEN BY HEAD

A One of the commonest situations for pain

B One of the commonest sites of gastric pain

C. Maylard gives this point opposite the 5th dorsal spine as one of the commonest locations of gastric pain my own observations and coincides more closely with the deductions of Head, who places the maximum points of tenderness in the seventh or eighth dorsal segments, opposite the ninth and tenth dorsal spines. Boas, on the other hand, locates the area of maximum tenderness as opposite the eleventh and twelfth dorsal spines. When pain is produced in stomach disorders, it may be felt in any of the areas supplied by the seventh, eighth, or ninth dorsal segments, but it is more apt to be felt, and felt more severely, in the maximal points of tenderness of these areas.

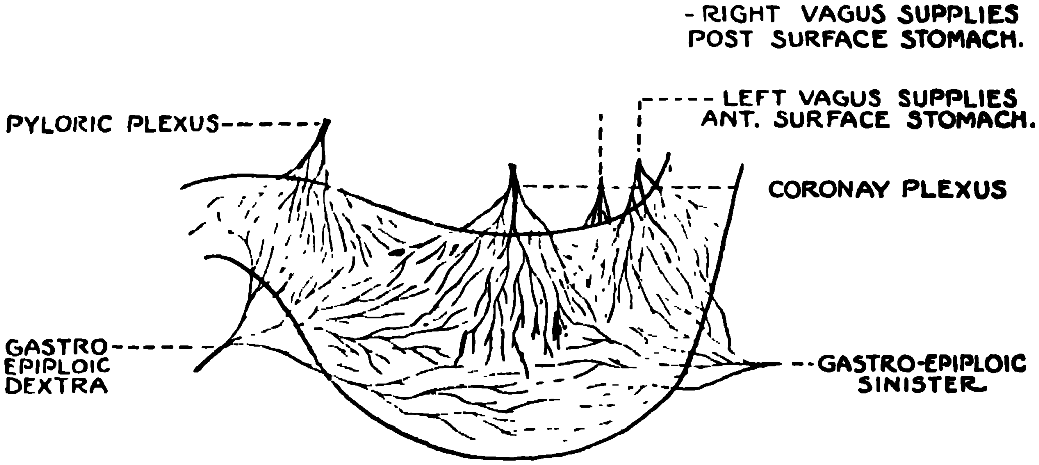
RIGHT VAGUS SUPPLIES POST SURFACE STOMACH.
LEFT VAGUS SUPPLIES ANT. SURFACE STOMACH.
PYLORIC PLEXUS
CORONAY PLEXUS
GASTRO EPIPLOIC DEXTRA
GASTRO-EPIPLOIC SINISTER

FIG. 90 —NERVOUS SUPPLY OF THE STOMACH.

In the accompanying drawing is shown the nerve supply to the stomach. It is seen to be both sympathetic (splanchnic, celiac ganglion) and cerebrospinal (vagus). True visceral pain is conveyed through the vagus, but it is of the deep-pressure sensibility (tension) type allied to Head's protopathic system.

The areas of tenderness are of great diagnostic significance. The hyperalgesic areas (Head) affected in stomach diseases are the seventh, eighth, and ninth dorsal. The seventh and ninth areas are those most frequently affected. The upper one, the seventh dorsal, seems to be associated particularly with the stomach diseases causing vomiting. When it appears, as a sequel to vomiting, it is frequently accompanied by pain in the area next to and above it, namely, the sixth dorsal. The sixth dorsal area is associated with disease in the lower part of the esophagus;

consequently, when both the sixth and seventh areas are affected the disease is somewhere near to and probably involves the esophagus. In the same way the ninth dorsal area is shared by both the stomach and the intestines, and when both are affected the lesion is probably in the neighborhood of the pylorus. When the seventh dorsal is involved, the pain, as a rule, comes on within half an hour after taking food; while, if the eighth dorsal is involved, the pain generally comes on at least an hour later.

By stimulating the area in the hypogastrium, which is hyperalgesic, a reflex contraction of the upper segment of the recti takes place. While in some cases only a segment, in others the entire rectus is thrown into contraction.

That the area in which pain is felt in stomach diseases does not necessarily correspond to the site of the gastric lesion, may be seen from the drawing (Fig. 98), where the projected outline of the stomach is shown, with the dark circle indicating the area of tenderness in gastric ulcer, the tenderness in no case being directly over the stomach.

PAIN IN GASTRIC AREAS

When pain occurs in the gastric areas, it is necessary to inquire into the following : (1) the character of the pain; (2) the time and manner of its appearance; (3) its relation, if any, to the ingestion of food; (4) the duration of the pain; and (5) previous attacks.

Character of Gastric Pain.—Certain types of gastric lesions have characteristic pains; for instance, that of gastritis is burning; that of spasm of the pylorus is sharp and sudden; that of ulcer is very severe and is sharply circumscribed; that of perforation is sharp and agonizing, and quickly spreads from the site of its original location; that of acute dilatation is severe and constant, and is accompanied by symptoms of collapse.

It should also be borne in mind that the severity of the pain has no proportionate relation to the gastric conditions, but often, as in pain caused by lesions in other organs, depends upon the susceptibility of the nervous system and the sensitiveness of the pain-receptive centers of the individual patient.

Time and Manner of Its Appearance.—Should the onset be sudden, without any apparent exciting factor, and without any previous history of pain, perforating ulcer or pyloric spasm is to be considered. In perforating ulcer associated symptoms of collapse and spreading peritonitis, with a diffusion and constant increase of the pain, would be present, while in pyloric spasm irregular paroxysmal pains that are sharply localized with no tendency to spread or to become generalized would be present.

Acute gastritis is associated with the vomiting of indigestible or fermenting substances; this generally tells the tale. If the pain is of slow onset, and there are at first discomfort, and then a gradually increasing distress until well-marked pain is present, particularly if the pain is associated with the vomiting of blood (coffee-ground vomitus), it is necessary to examine for gastric carcinoma.

Relationship to Ingestion of Food.—If the pain comes on at a definite time after eating, and is relieved by vomiting, gastric ulcer is thought of. If it comes on immediately after eating, the cardiac end is affected; on the other hand, if it does not appear for an hour or two after eating, ulcer of the pylorus is to be considered. If, instead of coming on immediately, it makes its appearance one-half to two hours after eating, carcinoma or hyperchlorhydria should be considered. In carcinoma the coffee-ground vomit is distinctive, while in hyperchlorhydria the excess of hydrochloric acid, with the absence of blood, is sufficient to make a diagnosis. In early carcinoma, pain and coffee-ground vomit are absent. Hyperchlorhydria may occur from gall-bladder disease, duodenal ulcer, or be purely functional.

Duration of Pain.—The duration of the pain in any of the gastric disorders is variable. It seems to be present more constantly and for a greater length of time in those disorders which have an organic basis for their production. In carcinoma the pain is steady and persistent, while in hyperchlorhydria and pyloric spasm it is associated with the ingestion of food.

Previous Attacks.—A history of previous attacks of pain may be of value, in that it often is confirmative of the diagnosis which the present symptoms would suggest.

Associated Symptoms.—Constipation is generally associated with gastric ulcer, hyperacidity, and carcinoma.

Pain Reflected or Referred to Gastric Areas.—When pain is present in the gastric areas, it may be not of gastric but of nervous origin (intercostal neuralgia), or it may be projected from the cord (locomotor ataxia, general paralysis, disseminated sclerosis), or it may be a reflex from other organs, as the uterus, kidney, intestines, appendix, gall-bladder, pancreas, heart, or prostate.

LESIONS OF STOMACH CAUSING PAIN

The commoner lesions of the stomach causing pain are: (1) displacement; (2) gastralgia; (3) hyperchlorhydria; (4) cardiac or pyloric spasm; (5) acute dilatation; (6) acute gastritis; (7) chronic gastritis; (8) gastric erosions; (9) gastric ulcers; (10) perforating ulcer; (11) new growths, and (12) perigastric adhesions.

Displacement of the stomach (gastroptosis) generally causes no pain until it induces a dilatation. Then the sensation produced is rather a disagreeable, nauseating feeling than a true pain. It is increased by eating or by standing, and is decreased on lying down or on supporting the abdomen by a bandage judiciously applied.

Gastralgia or Gastromyalgia.—By many gastralgia is disclaimed as a misnomer, because it is said that there is no such pathological entity. But why? The stomach is an organ whose walls consist of muscular tissue, and why should not this tissue, even though it is involuntary, be subject to the same metabolic disturbances as are the muscles of the back, which under abnormal metabolic changes give rise to lumbago? The only difference is that in the affected back muscle the changes act principally on the terminations of sensory nerves in the muscles, while in the stomach walls the nerve terminals affected are not sensitive in the meaning that they convey pain or touch sensation. Therefore, for this irritation to be perceived as harmful, that is, painful, it must be carried to the cord, where, irritating some sensory neuron, the stimulus is carried to the brain, where it is perceived as coming from the area of distribution of this neuron. That such a changed metabolic and at the same time pain-producing lesion may exist in the stomach is in accord with the opinion of the majority of observers. The condition, instead of being termed gastralgia, which is only a general term, should be called gastromyalgia, although the term gastralgia is still in general use.

Schmidt claims that "the existence of true gastralgia resulting from purely anatomical and functional disturbances is as certain as the pain of dental caries." Maylard describes it as "occurring generally in those of a neurotic taint; and the pain may be of the most excruciating character, seizing the patient in the epigastrium, and striking through to the back, radiating sometimes round the chest or waist." It is most erratic in the time of its appearance. Sometimes it follows the ingestion of food, while at other times it appears without any known cause. It may sometimes appear periodically at night, and at other times it may follow upon any excessive draft upon the nervous system by worry or excitement. The pain is "generally out of all proportion to other physical symptoms of any suggestive physical disease. The patient may also complain of a beating sensation, pulsating sensation, a feeling of heat or cold. Periods of pain generally alternate with periods of complete freedom from it."[1]

The symptoms usually associated with this condition are flatulence, distention, anorexia, cravings for food, vomiting, and pyrosis. The stomach pains frequently alternate with attacks of migraine (same as in angina pectoris), neuralgia of the head, and asthma. Women are more prone to gastromyalgia than men, in the proportion of two to one, and it is most common between the ages of twenty and forty-five.

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[1] This consideration of the subject differs markedly from that given by Schmidt, who classifies all gastralgias as neuralgic in origin. While it must be admitted that stomach pain depends upon the irritation of nerve terminal filaments for its production, yet, as mentioned above, in a somewhat though not entirely similar condition in the voluntary muscles, the term myalgia is used. It seems that an analogous term, such as gastromyalgia, should be used for pain having its origin in the stomach musculature. The general term gastralgia, therefore, is ill-fitted, and is only to be used in a general way to include those pains originating in the stomach, the etiology of which cannot be definitely determined.

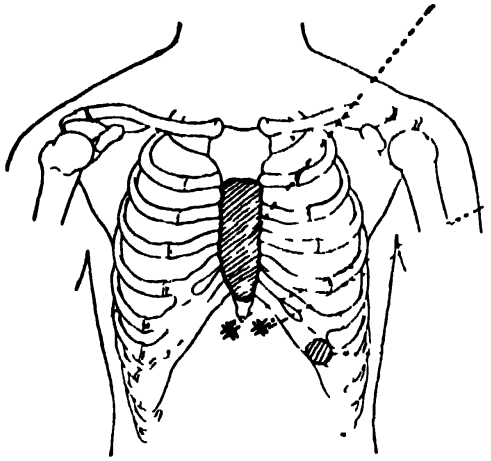
On the other hand, neuralgia of the stomach is entirely different in its etiology from gastromyalgia, but is included, as are all stomach-productive pains of unknown etiology, under the generic term "gastralgia."

In an entirely different class, but slightly related to the pains we have just described, are those due either to a secretory or a motor disturbance. These will be considered later under their proper headings. In the meantime it is well to remember, in considering the cause of stomach pain, that the lessened resistance of the nervous system to pain-production is of manifest importance. Some people, owing to disease or inherited predisposition, are abnormally sensitive to pain, so that the perception of sensations, which in others ordinarily would not even be disagreeable, would be felt by them as sensations varying all the way from distress to actual pain. In this connection it is helpful to know that gastric pains not of purely nervous origin are influenced by the ingestion of food and the position of the patient, while those of purely nervous origin are not.

The diseases acting as predisposing causes of gastromyalgia or gastroneuralgia are about the same as those which cause a lessened resistance in the nervous system, and which are productive of cerebrospinal neuralgia. Among them may be mentioned anemia (chlorosis), infectious diseases, rheumatism, syphilis, influenza, tuberculosis, excessive use of stimulants (alcohol, tea), sexual over-indulgence, gout, diabetes, uremia, and physical depression.

The reflexes which are sometimes felt as pain in the gastric reference area, and which in some cases are even accompanied by vomiting, will be considered under the reflex pains of the appropriate viscera, though for clearness of conception they will also be described in our consideration of the diagnosis of stomach pains. These reflex pains in the epigastrium, associated with vomiting are due to disease of the gall-bladder, pancreas, appendix, uterus and appendages, etc., should not, as is done by some authors, be placed under gastralgia, but should be considered under the lesions of the different organs producing them. This is sometimes very difficult, for, in many cases, it is not easy to distinguish the origin of the different pains; for instance, gall-stone colic is often confused with gastric pain, yet it may be distinguished from it by its paroxysmal character, its tendency to become localized to the right and to extend around the right side to the area underneath the right scapula. At the same time it is associated with localized gall-bladder tenderness, and often there is a well marked enlargement of the gall-bladder and sometimes a generalized jaundice. Angina pectoris has also been confused with gastric pain. Here the pain, as a rule, follows exertion, and radiates into the left arm and hand. The heart may be tumultuous in action, and frequently there are severe depression and a fear of death. The appendix, also, has in many cases been found to cause epigastric pains; but here epigastric pain, with no tenderness over the epigastrium, but over the appendiceal region, is present. There may also be a palpable mass in the same region, and the pain and tumor are associated with vomiting, eructation of gas and constipation. Of diagnostic importance in differentiating pain of local origin from referred pain is the administration of local anodynes, as cocain, alypin, menthol, and phenol. These generally cause the pain to lessen or cease when it is of local irritative origin, such as occurs when the lesion is in the mucous membrane, namely, in ulcer, carcinoma, etc. When no effect is noticed, after the administration of the local anodyne, neurotic lesions should be considered. Of considerable diagnostic importance is the fact that gastromyalgia is frequently relieved by pressure.

Hyperchlorhydria. – Hyperchlorhydria is the only secretory neurosis of the stomach which produces pain. This pain comes on one-half to two hours after eating, and lasts a few hours, or until more food is taken, being particularly relieved by the ingestion of proteids, and also by alkalies. It is much less after large meals, especially those containing much meat and eggs and deficient in carbohydrates. The pain differs from that due to gastric ulcer in being diffuse and extending over the entire abdomen. It seems to be frequent in persons of neurotic temperament, and is commonly associated with gall-stones. Hyperchlorhydria is also frequently associated with neurotic motor disturbances. The pain produced by it often is accompanied by a considerable belching of gas, generally preceded by a burning sort of pain, which seems to run up under the sternum to the throat, and is accompanied by the regurgitation of acid-tasting fluid. The pain may also radiate to the back, to the axilla, and to the scapula. In some instances the pain seems to be due to the presence, even in small quantities, of hydrochloric acid. In these patients there is a peculiar antipathy of the stomach to the presence of any acid. The examination of the stomach contents often shows a normal or even a subnormal percentage of acid.



This substernal pain represents the esophageal component of the pain symptoms

Tenderness on deep pressure

Area of hyperalgesia to pin point pressure. Over this area there is also pain to deep pressure. It lies about the junction of the 7th left costal cartilage with the 7th rib

FIG. 91.—LOCATION OF THE PAIN SYMPTOMS IN A CASE OF HYPERCHLORHYDRIA.

Hertz has shown that the gastric mucosa is not painfully stimulated by excess of hydrochloric or other weak acids. It is probable that the heartburn of so-called hyperchlorhydria has nothing whatever to do with acid production, and that the term is a misnomer. The hot sensation is closely related to that felt following the ingestion of alcohol, and is felt most often following slight regurgitation due to the presence of excessive amounts of gas. Hertz maintains that heartburn is an esophageal sensation, not a gastric one, and is due to the stimulus of excessive carbohydrate fermentation (hot bread—biscuit—causing the so-called pudding heartburns). This causes the production of alcohols, ethers, and organic acid in the stomach, which by regurgitation act upon the lower end of the esophagus, thus giving rise to the classical heartburn erroneously interpreted as a hyperchlorhydria. For a further interpretation of the causes of pain in hyperchlorhydria, see gastric ulcer.

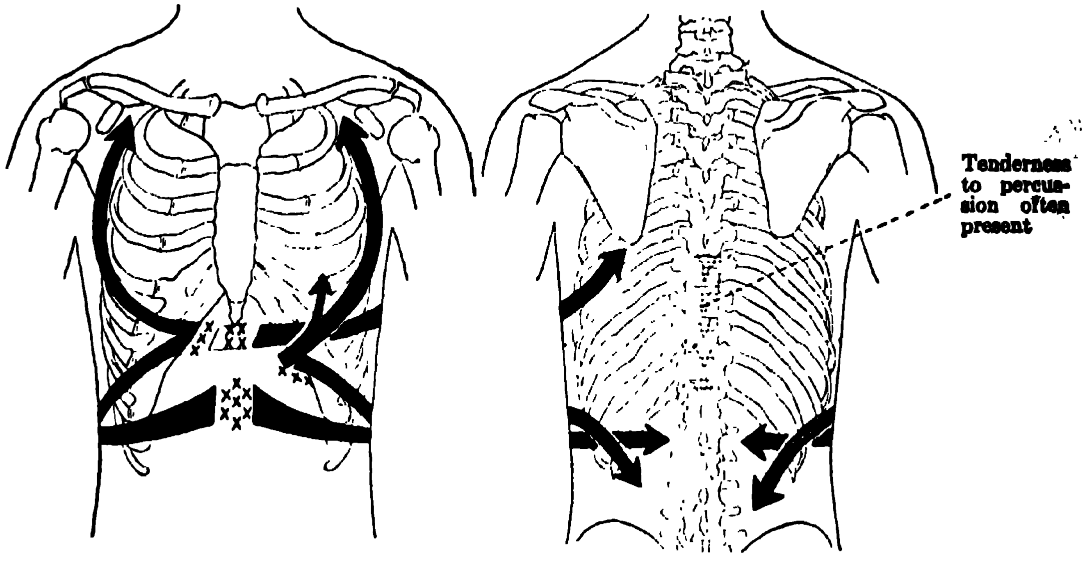


Fig. 92.—Pain Radiation.
Crosses indicate the sites of pain and the lines with arrows indicate the direction of the pain radiation.

Pyloric or Cardiospasm.—The stomach resembles other divisions of the hollow abdominal viscera in that it is subject to colic; but the parts chiefly affected are the pylorus and the cardia, as the intervening portion has so great a lumen that it contracts en bloc less readily. Then, too, this part of the stomach is so situated, and its attachments to the adjacent viscera are so arranged, that it may undergo considerable distention without any symptoms being produced; but as soon as the distention becomes excessive and traction is made on its peritoneal and diaphragmatic attachments, pain results. The same is true, when, owing to the contraction of the pylorus or cardia, a change in the relationship of these two parts to the surrounding viscera results, and a pull on their peritoneal attachments occurs.

By reference to the anatomy it is seen how the cardia of the stomach is immediately below the opening in the diaphragm, and how, when it contracts, especially when the stomach is full, there must be a stretching of the gastrophrenic ligament, with resulting pain. The same is true of the pylorus, but here the pull is made on the gastrohepatic omentum, and possibly also on the gastrocolic omentum. Hertz claims that the pains in pyloric or cardiac spasm are really tension pains, due to distention of a segment of the stomach. In pyloric spasm a persisting contraction of the pylorus occurs as a reflex from the presence of an excess of HCl in the stomach. The peristaltic wave in the stomach, being excessive from the HCl stimulation, pushes the food onward until it reaches the prepyloric part of the stomach; from here, owing to the closure of the pylorus, it cannot advance further, and tension is made upon the stomach walls at this point.

From this it would seem that not only is the small part of the stomach at the pylorus involved, but that also a large part, if not the entire stomach musculature, is involved in the contraction. It is hardly probable that the contraction of the constricted part of the bowel at the pylorus could so alter the relationship of this one part to the gastrohepatic or gastrocolic omentum that the stretching of it would be great enough to cause the severe and widely diffused epigastric pain which is sometimes present. Another argument in favor of the participation of the muscular wall is that the pain is relieved by vomiting.

A somewhat similar cause exists for the pain in hour-glass stomach. Here a portion of the stomach is contracted, and an hour-glass stomach results. The food entering the upper compartment is pushed forward by the peristaltic waves until it reaches the place of contraction; here it is unable to progress further, and at this point tension is made on the gastric walls, and pain results. As would be expected, the pain is not felt when the stomach is empty, but results only after ingestion of food and drink. It is relieved by vomiting.

The cause of pain in cardiospasm is the dilatation of the terminal portion of the esophagus. This is the result of stasis of food, due to spasmodic closure of the cardiac sphincter. In cardiospasm the pain comes on immediately after eating, is fairly constant, and seems to be located beneath the costal margin at the left seventh costal cartilage, while in pyloric spasm the pain is localized in the midline, about midway between the umbilicus and ensiform, and comes on two or three hours after eating, *i. e.*, at the time of the passage of the gastric contents through the pyloric opening. Both pains have a typical paroxysmal gripping or twisting character, and are equally severe. The pyloric spasm generally is relieved by vomiting, while cardiospasm gradually passes off, no vomiting, as a rule, occurring. In both midnight attacks are very frequent. It seems also that in some cases the contraction of the cardiac and pyloric sphincters alone can cause reflected pain, this pain being due to the unusual squeezing of the nerve terminals in the muscular tissue, the result of the abnormally severe contraction. For the production of pyloric spasm pain it is not always necessary that the stomach be full, for in many cases when it is empty the irritation of the gastric secretions (which in this condition are often highly acid) will produce it. Also, it can be relieved by washing out the stomach.

A similar contraction of the musculature of the pylorus and, in some cases, of the entire stomach and duodenum is the cause of hunger-pain. This differs from cardia and pyloric spasm in that it can be relieved by the ingestion of food, provided the stomach mucosa and musculature are intact. The ingestion of food will not relieve the associated hunger-pain present in ulcer or carcinoma of the stomach, because the food, of itself, is an irritant in such conditions, and aggravates instead of easing the spasm.

In all these conditions, after the pyloric spasm has persisted for some time, a dilatation of the stomach results. This dilatation, in turn, causes gastric pain, because of the traction and pull of the gastric walls on the omental attachments. The pain is of the same kind as described in acute dilatation of the stomach, only in dilatation the result of pyloric spasm the pain is added to the previously existing spasm pain. In acute dilatation also, the pain is more generalized, and becomes constant, while the pyloric-spasm pain is paroxysmal. In case of dilatation of the stomach the epigastrium is distended, the outlines of the stomach are plain, and visible gastric peristalsis can be seen; also, on listening, borborygmi and bubbling noises can be heard. Succussion sometimes gives rise to a splashing sound. Eructations of sour-tasting fluid are also present. These associated symptoms generally come on when the pain is most severe. If vomiting occurs, and the spasm has been of some duration, large quantities of gastric contents are expelled. Sometimes the attacks of colic are accompanied by a mild chill of nervous origin, elevation of the temperature being entirely absent.

Pressure on the distended stomach is well borne, and is frequently applied by the patient, because it seems to aid in the forcing on of the stagnated stomach contents. The pain is increased by the eating of indigestible foods. According to Schmidt, cold applications to the epigastrium seem to be better borne than hot ones, and to be more beneficial to the patient.

Acute Dilatation of the Stomach. Acute dilatation of the stomach frequently is a cause of the most severe pain. It is prone to occur after operations, especially those in which there has been considerable handling of the abdominal viscera. It comes on, as a rule, three or four days following the operation. By many it is held to be only a symptom of a peritonitis, which, it is claimed, is present in every case of such vomiting. At first there is a feeling of distress in the epigastrium, which soon increases until severe pain is felt. This is generally accompanied by the vomiting of a greenish fluid, and by a gradual abdominal distention, with rise of pulse rate, and signs of severe systemic distress. This state, unless relieved, is rapidly fatal. Acute dilatation also occurs in many patients who have not been subjected to operative interference, but generally it is not of as severe a form as in the operative ones. In both of these conditions the pain is of a diffuse nature, and is located in the epigastrium. Because of the acid condition of the stomach contents, the pain may be partially relieved by the ingestion of alkalies; but the only sure relief is from repeated stomach washing. Should stomach distention be suspected, it can be confirmed or disproved by percussion and palpation, as well as by the stomach tube, by which, if gastric dilatation is present, large quantities of greenish fluid may be removed.

In some cases distention of the stomach may be associated with distention of the duodenum, and, when this occurs, as in a case reported by Torrance (577), there may be pain under the right shoulder and over the eighth and ninth ribs to the right of the spinal column.

The pain of gastric dilatation is also partially due to the traction which the diaphragm exerts on its costal attachments, owing to the upward force exerted upon it and its consequent displacement by the distended stomach.

Acute Gastritis.—Although the stomach has no special tactile sensory nerves, it reacts painfully to inflammatory lesions. When inflammation is present in the stomach walls, the adjacent lymphatics become involved, lymphangitis results, and this inflammation spreads to the parietal peritoneum through the immediate attachments, and causes it to become hypersensitive. At the same time the inflammation of its walls causes the stomach to become very irritable, and to react much more strongly than usual to stimuli; so that, on the entrance of food and drink, it contracts to a greater than normal degree. This produces traction much greater than normal on the inflamed mesentery, and at the same time causes tension within its own muscular coat and pressure upon the nerves of deep sensibility with resultant pain.

In gastritis the subjective pain is felt in the epigastrium, and at the same time the gastric areas of hyperalgesia (Head) may be present. The subjective pain is of a dull, aching character, increasing to a sharp, burning on the ingestion of foods. Another characteristic of this pain is that it seems to run directly through to the back, this being most probably the result of the irritation of the inflamed peritoneum around the cardiac opening, which lies very much closer to the back than it does to the anterior abdominal wall. On making pressure over the epigastrium, pain is elicited; light pressure bringing out, in many cases, the hyperalgesic areas of Head, while deep pressure brings to light the tenderness of the subserous peritoneum, which, because of its lymphatics, is frequently involved in the inflammatory process. This pain varies in intensity and seems to have some relationship with the severity of its lesion, so that the extent of the gastric inflammation may partially be judged from the magnitude of the pain.

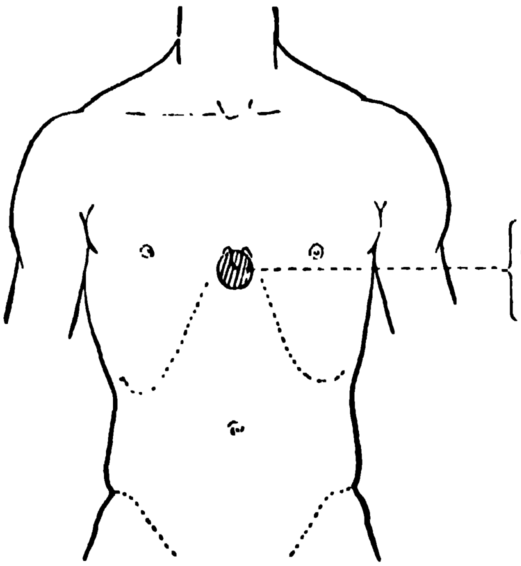

Pain in epigastrium goes directly through to the back. Pain between shoulders is also sometimes present

FIG. 93.—FIGURE ILLUSTRATING THE LOCATION OF PAIN IN ACUTE GASTRITIS.

The pain of acute gastritis is fairly sudden in its onset. It may follow a night of alcoholic indulgences, or occur after the eating of indigestible substances, and is associated with nausea and vomiting. It may be so severe that morphin is required to relieve it. In some cases there are an elevation of the temperature as high as 104 ° F. and an increased rapidity of the pulse. The recti muscles of the upper abdomen are also contracted, especially on the left side, and are slightly tender on palpation.

Chronic Gastritis.—Chronic gastritis is generally not painful, though after eating there may be a feeling of discomfort. Riegel, according to Gilbride, claims that in the atrophic forms of gastritis the pain resembles that of the gastric crisis of tabes.

Gastric Erosions.—Gastric erosions, as pathological entities, occupy a position intermediate to gastritis and ulcer. Pathologically they are less extensive than ulcers, and more intensive than gastritis. The pain produced is of a dull aching character, and seems to extend throughout the entire stomach area. It is not affected by pressure or by change of position. It generally comes on after eating, persists an hour or two, and then gradually subsides; but it may be present irrespective of the intake of food, and intervals may be present in which there is absolutely no pain. The course of the disease is prolonged. Emaciation, loss of appetite, and, in many cases, hematemesis may result.

Gastric Ulcer.—Gastric ulcer, in its pain production, depends upon practically the same factors as does gastritis. The lesion in ulcer is circumscribed, while that of gastritis is diffuse. Both are associated with lymphangitis, and it is this lymphangitis which contributes greatly to the pain that is produced. That the pain and tenderness which are felt on palpation are not present in the stomach but in the abdominal wall can be demonstrated from the following premises:

(1) The ulcer, in most cases, is on the posterior wall of the stomach, and pressure upon it through the abdominal wall, rigid because of the contraction of the rectus, is almost impossible.

(2) The pain and tenderness are constant, while the relative position of the ulcer is always varying, depending upon movement of the stomach due to respiration, peristalsis, distention with food, liquids, gas, etc.

(3) On exposure of the stomach by exploratory laparotomy the ulcer may not be found immediately beneath the area in which the pain and tenderness had been felt.

In the following drawing, Mackenzie (586) illustrates the relative position of the pain and the site of the ulcer. In his cases the site of the ulcer bore no relationship to the site of the pain; but when the ulcer was near the cardiac end of the stomach the localized pain and the cutaneous and muscular hyperalgesia were situated high in the epigastrium, while if the ulcer was situated near to the pylorus it caused pain low down in the epigastric region.

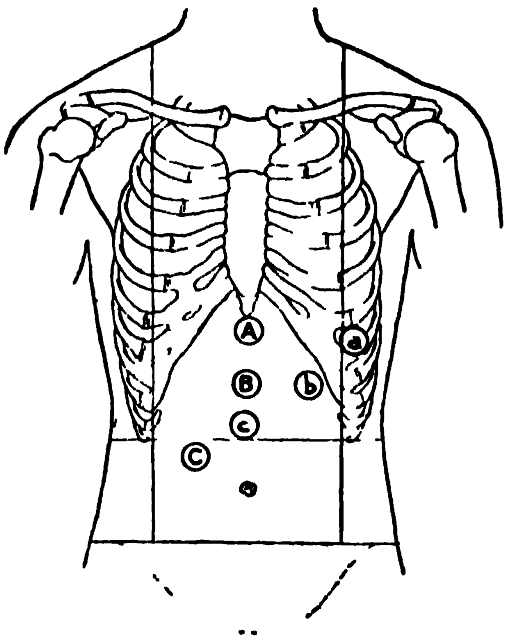


Fig 94 — Location of Pain in Gastric Ulcer

In the figure the area A shows the area of pain when the ulcer was at the cardiac end of the stomach a, B when the ulcer was in the middle of the lesser curvature b; C when the ulcer was at the pylorus c.

It is claimed that in some cases it is the contraction of the pylorus which causes pain; in others that it is the contraction of the bundle of fibers which surrounds the prepyloric region of the stomach and separates the antrum pylori from the rest. In one case Moullin reports a cure from the ulcerated condition and the pain by section of these fibers (Mansell Moullin, 578).

In this case neither ulcer nor scar could be found when the stomach was opened, so that it was probably only a case of hypertrophied pylorus.

That the pain in gastric ulcer is not due to hyperacidity of the stomach contents can be deduced from the fact that increase in the hyperacidity, due to the ingestion of acids, produces no increase in the pain. It has also been shown that pain cannot be produced by irritation of the normal mucous surface of the stomach. The researches of Hertz also tend to show that an ulcerated surface is insensitive to acids in the strength found in the stomach.

In some patients an ulcer of the stomach causes no pain. When this occurs the ulcer is generally situated on the anterior surface, near to the cardia, no adhesions having formed between it and the parietal peritoneum. C. W. Habershon, in 1859, was one of the first to show that ulcer confined to the mucous membrane alone was not painful. He likewise claimed that cancer and other diseases, while restricted to the mucous membrane, produce no pain.

The pain of gastric ulcer can generally be distinguished because of its several characteristics, as follows:

(1) *Time of Onset.*—Pain generally begins immediately on the entrance of food into the stomach, and gradually increases until it reaches a climax (at the time the pyloric end is at work), and then, as the stomach empties itself, it becomes less and less, and gradually disappears. It is also relieved by vomiting, and in many cases by the ingestion of alkalies. After an hour or two it ceases. The longer the interval between the time of ingestion of food and the appearance of the pain, the farther away from the cardia and the nearer to the pylorus is the ulcer. If it has occurred immediately after eating, the ulcer is probably near the cardiac orifice or the lesser curvature; if two or three hours after, it will be at the pylorus; and, if four hours after, and relief ensues on taking food, the ulcer is probably in the duodenum.

(2) *Character.*— The pain, as a rule, is of a dull, boring character, and is generally localized to a small area in the epigastrium. It may radiate to the back. Sometimes, instead of a pain, there is present in the epigastrium a dull, disagreeable, constant sensation. When this is present, adhesions, peritonitis, and increased continuous secretion of gastric juices are likely to be found. The statement that the ulcer can be mapped out by percussion is manifestly absurd, as can readily be understood from a study of the origin and propagation of gastric pain. A peculiarity worth noting is that the pain is most severe when the ulcer is located on the posterior surface, because, in this location, it is nearer to the parietal peritoneum, upon which there is more drag than would occur if the ulcer was situated upon the anterior surface. In some cases there may be a burning sensation after eating, and the pain may radiate to the sides of the chest and shoulder. The sensation varies from a feeling of distress, that is hardly notice-

able, to a pain of the greatest severity. This pain has been described as cutting, gnawing, piercing, or burning.

The pain of pyloric ulcer is, as a rule, greater than that of cardiac ulcer.

A very strong reason why this should be so is that the pylorus is relatively a fixed portion of the stomach, and in distention or contraction of the stomach it does not change its position according to the change in the position of the remainder of the stomach, consequently pull is made upon it, and it is this pull upon the already irritated structures that causes pain. This pain seems to occur most frequently in the mid-hours of the night. In some cases psychical disturbance, as anger or great emotion, seems to be conducive to its onset.

(3) *Tenderness.*—In gastric ulcer, the tenderness which is in the epigastrium, in many cases to the right of the median line, may, because of adhesions, be localized in other parts of the abdomen. Ulcer of the stomach differs from gall-stone and all other colics, in that the patient is very sensitive in the upper abdomen, so that in many cases he will not bear even the slightest pressure, which is exactly the opposite to what occurs in colic, for here pressure seems to give relief. The tenderness to palpation and percussion associated with ulcer seems to vary according to the degree of distention of the organ—the greater the distention the more severe the associated pain.

The tenderness elicited on palpation is of two types, superficial and deep. The superficial tenderness is merely an expression of the hypersensibility of the skin, while the deep tenderness expresses the hypersensibility of the muscles, subserous peritoneum, and the peritoneum (parietal) in immediate association with the ulcer. When the tenderness is due to a hypersensibility of the rectus muscle, it will be found that the muscle is in a state of contraction, and that this contraction is localized to the upper segment. The contraction is more marked, generally, on the right side than on the left. This localized contraction, the so-called visceromotor reflex of Mackenzie, has, in some cases, been mistaken for a *tumor.* Sometimes, if the patient is very stout, it

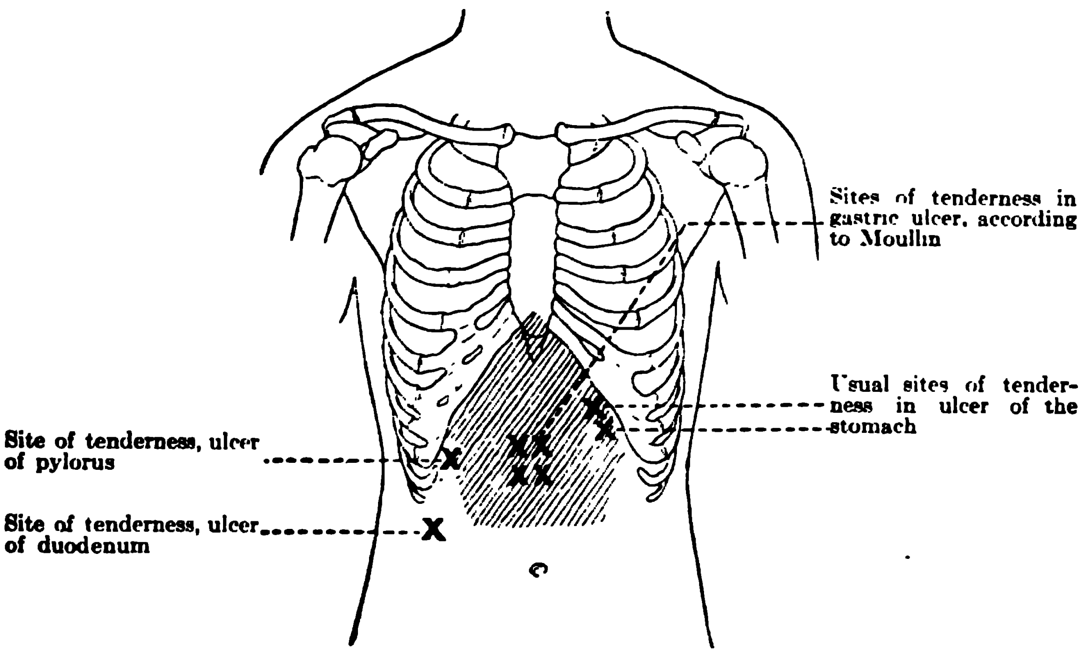

Sites of tenderness in gastric ulcer, according to Moullin
Usual sites of tenderness in ulcer of the stomach
Site of tenderness, ulcer of pylorus
Site of tenderness, ulcer of duodenum

FIG. 95.—SITES OF TENDERNESS IN GASTRIC ULCER, ULCER OF PYLORUS AND ULCER OF DUODENUM.
(Drawing modified from Keen's "System of Surgery," Vol. III, p. 829.)
Shading indicates the areas in which tenderness may be found.

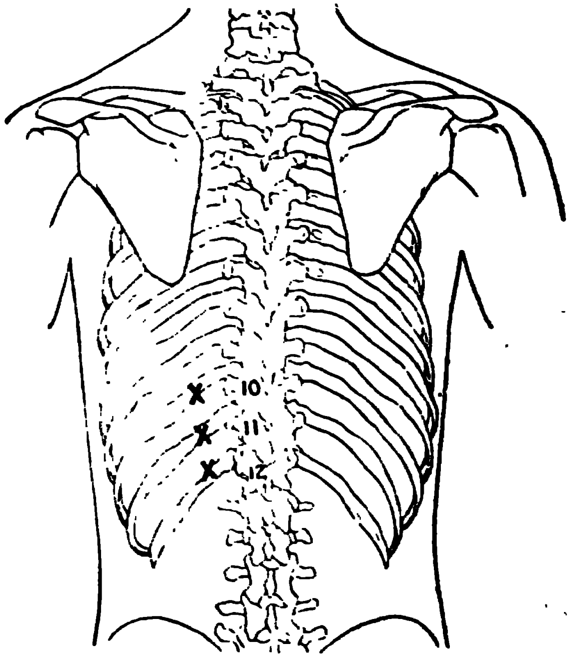


FIG. 96.—SITES OF TENDERNESS IN GASTRIC ULCER, POSTERIOR VIEW.
(Drawing modified from Keen's "System of Surgery," Vol. III, p. 829.)

is difficult with ordinary palpation to elicit pain in the rectus. It then becomes necessary to make very firm pressure, with the abdomen as relaxed as possible, so that the area of tenderness may be defined. After having examined the abdomen it is well to examine the back. Here a tender area to the left of the tenth, eleventh, or twelfth dorsal vertebræ may be present. Percussion is frequently used to exactly define the area of tenderness. The lymphatics from the pylorus are in association with the upper abdominal wall on the right side, while the lymphatics from the cardiac end of the stomach are distributed to the upper abdominal wall on the left side. Since ulcer is most common at the pyloric end of the stomach, this will account for greater frequency of increased rigidity of the right rectus.

(4) *Diet.*—Foods causing the production of pain, or increasing the pain already present, are those which are of an irritating nature or are difficult to digest. Of the first, are corn, crusts of bread, some breakfast foods, as grape-nuts, cherries which have been swallowed with their pits, etc. In the second class, pork, fresh baked bread and hot rolls, boiled cabbage, cucumbers, unripe fruits, strongly spiced foods, the various salads, and potatoes may be included. Of the liquids causing an increase of ulcer pain, are those which are highly acid, or those which contain alcohol, as whiskey and beer. In many cases, also, those drinks which in themselves are stimulating or irritating, as coffee and tea, increase the pain. Cold drinks likewise sometimes induce a paroxysm of pain. The foods which are well borne in ulcer are meats, particularly scraped meat (beef), milk with lime water, and farinaceous gruels. Smoking sometimes seems to induce pain. Possibly this is a result of a stimulus to contraction known to be caused by nicotin. If the ulcer is situated near the pylorus, and the stomach is adherent to the pancreas, the pain is felt most severely in the intervals of gastric digestion. It is temporarily relieved by food or draughts of water.

(5) *Change of Position.*—If the pain is worse in certain positions it can be assumed that the position in which it is worst is the one in which the stomach will be so situated that pressure

will be made upon the ulcer by the stomach contents and abdominal viscera. A change of position will also, in many cases, cause a kinking or bending of the pylorus, and this, in turn, produces traction upon the ulcer-bearing surface, thus causing pain.

It seems to be the rule that a right lateral position of the body is most painful in ulcer of the pylorus. The opposite seems to be true in cases of fundus ulcer. This rule, though, is true only before adhesions have formed. After their formation such a change of position of the body that the stomach will have a tendency to drop away from and pull upon the adhesive surface, would cause an excess of pain in the ulcer and adhesion area. In all cases the pains due to change in the position of the body are increased at the time of the spontaneous attacks common to ulcer. In many patients, in whom the ulcer is on the posterior surface, relief is found during the attack by lying on the abdomen. Lifting, straining, carrying heavy loads, jumping, and rowing, and, in some cases, going up and down stairs, excessive respiratory movement, coughing and sneezing, running and walking may be provocative of pain. During attacks the patient may be crouched, the lower limbs being flexed, and the body bent forward. He may lie on the back or abdomen, or on either one or the other side, depending upon the location of the ulcer.

(6) *History.*—Gastric ulcer generally gives a history of attacks of left-sided pain, which may or may not be accompanied by vomiting. This pain gradually passes off, and the patient may be free for several weeks or months; but again the pain comes on and lasts a little longer than in the first attack. Thus the pain continues to come and go, each attack being of briefer duration than the previous one, and occurring at successively shorter intervals.

Conditions accompanying and associated with gastric ulcer are: (1) Vomiting, which comes on generally after the ingestion of food, especially if the food be of an irritating kind. It occurs one-half to two hours after eating, but may take place almost immediately. The vomitus of an ulcer patient is somewhat characteristic, in that it often contains pure blood.

(2) Constipation is frequently present.

(3) Anemia sometimes occurs, and is due to the loss of blood in the vomitus or in the stools.

(4) Blood is sometimes seen in the stools after a meat-free diet.

(5) Enteroptosis frequently accompanies pyloric ulcer. In this case a properly adjusted abdominal supporter, the taking on of fat, or the presence of pregnancy frequently eases the condition, the cause of the relief in the latter instance being due, as Schmidt suggests, to the elevation of the abdominal viscera by the rising of the enlarged uterus.

(6) Pyrosis or regurgitation of sour-tasting fluids sometimes occurs.

(7) Belching of gas and tympanitis are common. The belching of gas, with the accompanying sour-tasting eructations, is almost pathognomonic of gastric ulcer.

Perforating Ulcers.—The perforation of a gastric ulcer is one of the tragedies of medicine. It is ushered in with pain (Eisendrath, 579), which is severe and sudden, and of an intense, agonizing, or stabbing character. If the ulcer is on the anterior stomach wall, and is in intimate contact with the anterior abdominal wall, the pain may be felt at first around the navel. In either case, as the associated peritonitis extends down into the right iliac fossa, it rapidly becomes diffused. The original pain is now accompanied by the sharp, intense pain that is so characteristic of a spreading peritonitis. The abdominal muscles become rigid, and marked tenderness develops on the right side. A complication of this kind can be diagnosed from appendicitis in that the muscular rigidity in appendicitis is more markedly localized to the right iliac fossa, and also from the fact that in gastric ulcer there is often a history of hematemesis, pain after eating, and occult blood in the stools. If the case is first seen several hours after perforation, it is almost impossible, because of the associated peritonitis, to diagnose the origin of the pain.

Diagnosis of Gastric Ulcer.—The pain of gastric ulcer differs from that of gall-stone colic in the following ways:

(1) Pain in gall-stone colic is paroxysmal, and has a tendency to radiate over the right side to the right scapula; also it is felt in the right shoulder.

(2) Vomiting nearly always relieves the pain of ulcer, while it may have no noticeable effect on gall-stone colic. In ulcer the vomitus often contains blood. In gall stone colic none is present.

(3) Local anesthetics and mild drinks often ease the pain of ulcer. They would have no effect on gall-bladder colic.

(4) In gall-stone colic there is frequently a history of previous attacks, with an accompanying jaundice.

Cholecystitic pain is also often mistaken for ulcer pain; but in the former the pain is constant, and the enlarged and very tender gall-bladder can be felt. Pain of hepatitis has sometimes been confused with the pain of gastric ulcer, but in the former there is a tenderness beneath the right costal margin, and the liver is generally enlarged.

From epigastric hernia gastric ulcer can be diagnosed by the physical signs of the hernia which are present, and the impulse on coughing and straining. Duodenal ulcer is hard to distinguish, as the pain symptoms in the two conditions are almost identical, but alypin and cocain often relieve the pain of gastric ulcer, while they have no effect on that due to ulcer of the duodenum. To distinguish pyloric from duodenal ulcer Mennier (66b) has devised the following test. He gives the patient one pint of milk.

In Pyloric Ulcer	*In Duodenal Ulcer*
The pain is relieved after a few swallows, and gradually disappears.	The pain remains with the same intensity for 5, 10, or 15 minutes; then the patient belches gas, and suddenly the pain is relieved. This relief is synchronous with the opening of the pylorus, the belching of gas, and the passage of the stomach contents into the duodenum.

Acute pancreatitis often gives rise to symptoms similar to those of gastric ulcer; but here there are generally an associated shock and collapse. The pulse is considerably elevated, and a tumor (enlarged pancreas) often develops and lies across the upper abdomen.

Angina pectoris has also been mistaken for ulcer-pain; but the associated collapse and fear of impending death, the presence of unconsciousness, and the radiation of the pain to the left shoulder and down the left arm make the diagnosis easy. In angina pectoris vomiting does not occur, and diet, as a rule, has no effect on the incidence of the pain; but exercise and violent emotion seem to be inciting factors.

Appendicitis pain, especially if it occurs in the region of the umbilicus and is associated with vomiting, has frequently been mistaken for that due to gastric lesions. In appendicitis Morris's and McBurney's points may be tender, and there may also be reflected visceral hyperalgesia in the area usually associated with the appendix. These, with the absence of definite symptoms of stomach involvement, make the diagnosis certain.

Renal colic can hardly be mistaken for gastric-ulcer pain; the peculiar radiation of its pain downward and inward to the pubes makes its differentiation somewhat easy.

The pain of gastric carcinoma will be differentiated when it is considered a few pages further on.

The diagnosis of chronic ulcer of the stomach is easy, and when all of the classical symptoms are present can scarcely occasion perplexity. When, however, this is not the case, it may be exceedingly difficult, or even impossible, to make a positive diagnosis. Important diagnostic factors have already been indicated. Two other diseases of the stomach, gastralgia, or gastrodynia (as the expression of functional nervous disturbance), and carcinoma resemble the symptom-picture of ulcer when ulcer deviates from its typical course. It seems advisable to tabulate their important points of difference, as follows:[1]

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[1] Modified from "Modern Clinical Medicine," Diseases of the Digestive System, page 188.

NERVOUS GASTRALGIA	ULCER	CANCER
Tongue varies, is often pale, and fissured at the borders or upon the surface.	Tongue, dry, red, with white streaks in the center, or is smooth and moist, or slightly coated.	Tongue, pale; in rare cases, very red, dry.
Frequent eructation of odorless gas.	Eructations either rare, or acid with pyrosis.	Frequent fetid eructations.
Taste unaltered, dryness of mouth frequent; sometimes salivation.	Taste unaltered.	Pappy, insipid taste.
Appetite irregular, capricious. Eating brings relief.	Appetite good in the intervals; thirst, eating causes pain.	Appetite decreased or anorexia; early repugnance to meat; eating causes pain.
Varying sensations in the stomach, sometimes heat, sometimes cold.	Burning sensation in the stomach. Circumscribed boring pain, often radiating posteriorly.	Sensation of weight in stomach; drawing pains of varying character, perhaps pain in the shoulder.
Spasmodic, burning pain, independent of food, often ameliorated by the latter or by pressure upon the stomach. Pressure frequently eases the pain, though it is common for the anterior abdominal wall to be hyperesthetic.	Pains, gnawing, rare upon an empty stomach, usually appearing after eating or upon motion and on assuming positions which affect the stomach; increased upon pressure. Pressure points (hyperalgesic) upon back. Pressure over abdomen increases the pain. Sometimes at the time of paroxysms it will relieve the pain. Patients sometimes present the chlorotic type.	Continuous sensations of dull pain, periodically increasing to paroxysms, often produced by pressure or increased by it.
Often conjoined with hysterical symptoms. Occurs at all ages, more frequently in women than in men.	Most frequent in middle life; rare in children. Accompanied by a varying psychical condition, frequently great depression.	Most frequent between the 40th and 60th years. Psychical condition that of depression; melancholia, but, strange to say, less profound than in severe cases of ulcer.

NERVOUS GASTRALGIA	ULCER	CANCER
No tumor on palpation, unless, as rare exceptions, when foreign bodies (hair, etc.) have been swallowed. Chemism varies; absence of lactic acid.	When the ulcer is situated at the pylorus with consecutive hypertrophy, an ovoid, smooth tumor at the right of the median line may be palpated; occasionally, in old ulcers with a hard base and callous borders, a palpable circumscribed tumor may be felt. Perforation of the ulcer and consequent adhesions with the head of the pancreas, the left lobe of the liver, the spleen or the omentum, causes a tumor which does not move with the respiratory excursion. HCl present and usually increased.	Tumor of varying size and shape, nodular or smooth, distinctly palpable; as a rule, passively movable, occasionally also showing active excursions during respiration. In the majority of cases absence of HCl; absence of peptic digestion; lactic acid, lab-ferment sometimes absent (cancer of the pylorus), sometimes present (cancer of the fundus). Secondary glandular enlargement; metastases.
No symptom of perforation.	Perforation into neighboring organs with characteristic symptoms may occur frequently after apparent brief duration of the disease, even occurring without prodromes.	Perforation; implications of neighboring organs only after prolonged existence of the disease.
Most frequent about the time of the menopause.	Most frequent at from 15 to 35 years.	Most frequent late in life.
History of nervous disorders, as neurasthenia, hysteria, neuralgia, etc.	History of anemia, vomiting of blood, dyspepsia, tuberculosis, etc.	History of cancer in family, also of a gradually progressive weakness.
No pain between attacks.	Pain attacks may be absent for years, only to become again manifest.	Attack, when it comes on, generally lasts till cancer is removed or till death occurs.
Distention of stomach produces no pain.	Distention produces most severe pain, but it is a very dangerous procedure.	Distention is painful.

NERVOUS GASTRALGIA	ULCER	CANCER
Very little effect on general health	General health greatly affected	General health greatly affected.
The chemism of digestion not especially altered	Digestion of starches frequently slow, that of meat normal, or even accelerated; usually hyperchlorhydria	Digestion insufficient; usually absence of free HCl, and the formation of organic products of decomposition.
Epigastric pulsation Regulation of diet has no effect	Alkalies and albumins ease the pain	Epigastric pulsation present with marked emaciation Regulation of diet has no effect
Vomiting irregular, vomitus sometimes contains only mucus, sometimes more or less digested stomach contents, rarely mixed with bile	Vomiting as a rule, immediately or shortly after eating, and frequently the first symptom of the disease it occurs very rarely without the taking of food, vomitus hyperacid.	Severe and frequent vomiting, often periodic, occasionally, also, before the ingestion of food, vomitus is mucoid if acidity due to the presence of organic acids is present; vomitus shows but slight progress of digestion; sometimes cancer cells are present. Also in some cases the Boas-Oppler bacillus.
No hematemesis, except as accompaniment of very rare complications.	Vomiting of light red blood or coffee-ground masses, usually repeated in a brief space of time, occasionally very profuse, followed by extreme anemia and collapse, compensation with comparative rapidity; blood in the feces; occult hemorrhages.	Decomposed blood more frequent than fresh; quantity usually small, but, vomiting having once appeared, it recurs frequently at short intervals.
Almost invariably stubborn constipation; normal evacuations very rare; occasionally fluid mucoid dejecta, the so-called pseudo-diarrhea Mucous colic, that is, colitis mucosa membranacea	Bowel discharges vary, not infrequently diarrheal in consequence of intestinal irritation; lientery if perforation of the ulcer occurs into the colon	Almost invariably bowels stubbornly constipated; lientery after perforation of the ulcer into the colon.

NERVOUS GASTRALGIA	ULCER	CANCER
No fever.	Mild fever with adhesive inflammation after rupture of the ulcer, or following profuse hemorrhages	Fever rare, and only towards the termination of life; initial fever quite rare.
Skin pale, rarely ruddy Skin **of normal turgescence**	Skin usually ruddy, appearance good, anemic only after profuse hemorrhages; frequently the pallor is visible in the mucous membranes, and even in the cheeks	Skin sallow, yellowish, dry, and flaccid; marked cachexia.

New Growths of the Stomach. New growths of the stomach cause pain, especially when they encroach upon the pylorus and thus produce a partial obstruction with a consequent gastric dilatation. Carcinoma causes pain, particularly when it ulcerates, and when infection takes place, which gives rise to lymphangitis. According to Eisendrath, there is, in gastric carcinoma, at first only a heaviness after eating, then later a pain of a dull, gnawing character referred to the epigastrium. There is also a marked local tenderness. In carcinoma, or other new growths of the stomach, generally there are in some stage of their development characteristic areas of cutaneous hyperalgesia. The figure on the next page illustrates the areas mostly involved.

One of the earliest symptoms of carcinoma is the feeling of pressure in the epigastrium, occurring a short time after eating. There may also be sensations of burning, fulness, or of epigastric tension. When the pylorus becomes stenosed the pains assume a boring or twisting character, and are due to the spasmodic contraction of the stomach, which is attempting to force its contents through the narrowed opening. When the cancer is at the fundus pain is present, *more especially* when the stomach is full, and may radiate towards the breast and back. In some cases it is started by the ingestion of food, while in others it is produced by mechanical shock or by change of position.

The pain in gastric carcinoma may vary in location, depending a great deal upon the site of the new growth. It seems as though the nearer the growth is to the pyloric end of the stomach, the farther to the right and the closer to the umbilicus will be the pain. Sometimes this pain radiates around the sides to the back,

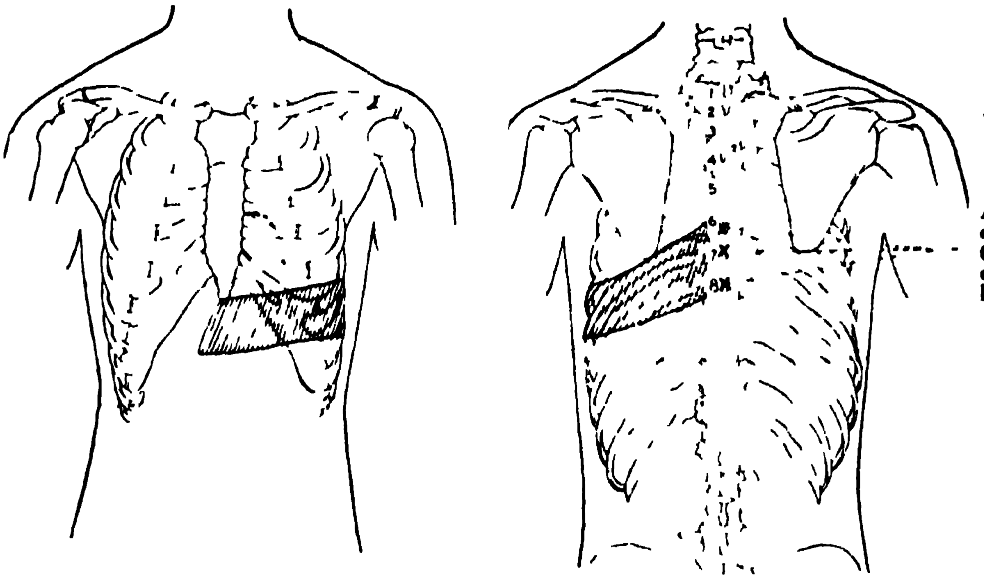
Areas of tenderness over 6th, 7th, 8th dorsal vertebræ

FIG. 97. HYPERALGESIC ZONES IN CANCER AT CARDIAC END OF STOMACH.

and rests between the shoulders, or runs anteriorly up under the lower part of the sternum; or it may radiate backward into the iliac regions. The reason for this is not clear. The appearance of pain on the back seems to be favored by constipation (Schmidt); it is relieved by purgation. Pain is also frequently present in the supraclavicular region on the left side.

The pain in gastric carcinoma is greatly increased when infection takes place, and a perigastric peritonitis results. The local tenderness is also much increased, and extends over a wider area. Creaking sounds, due to the movement of the inflamed peritoneal surfaces over each other, may be heard on auscultation, or be felt on palpation. The pain is constant; and is increased on the taking of food. Carcinoma, although having a resemblance to gastric ulcer, should be distinguished in diagnosis. In gastric ulcer pain comes on immediately after the ingestion of food; no tumor mass is found; a localized area of extreme tenderness is present in the epigastrium; and the stomach contents yield an excess of hydrochloric acid with the absence of sarcinæ and lactic acid. The exact opposite of these conditions prevails in gastric carcinoma. In gastric ulcer the pain generally occurs in attacks at irregular intervals, and frequently a coffee-ground vomitus is present, while in carcinoma the pain is more continuous, and coffee-ground vomit is, as a rule, absent. In gastric ulcer the ingestion of food increases the pain, while in gastric carcinoma this is less liable to occur. In some cases of carcinoma, in which ulceration has occurred, the pain has a character similar to that of gastric ulcer.

The posture of the patient generally plays but a minor rôle in the production of pain in gastric carcinoma, though the pain is worse in that position in which there is an excess of pressure upon the carcinomatous mass, or in which an abnormal degree of traction is exerted upon the surrounding tissues. Generally, since the carcinoma is most frequent at the pyloric end of the stomach, lying upon the right side is more painful than lying on the left. In case adhesions have formed, change from one position to another may be very painful. Rapid changes of position are generally productive of pain, because of the sudden movement of the tumor mass from one place to another.

It is claimed that benign stenosis of the pylorus is much more painful than is carcinomatous stenosis, because in carcinomatous stenosis the patients early lose their appetite, and there is no great mass of irritating food clamoring for passage, as in a benign pyloric stenosis. Also, owing to carcinomatous invasion and lack of nutrition, the musculature of the stomach in carcinoma soon becomes weakened, and is unable to exert as great a propulsive force upon the contained food mass as in pyloric stenosis. These conditions are present only late in carcinoma; early in the disease, the diet being the same as in benign stenosis, the pains of carcinoma may closely resemble those of the latter. Sometimes in carcinomatous pyloric stenosis the colicky pains may come on several hours after eating. They are common about one or two o'clock in the morning. In this respect carcinoma resembles gastric ulcer.

The pain in gastric carcinoma is due to:

(1) *The Local Disease.*—In gastric carcinoma, although hydrochloric acid is not present, other organic acids, such as lactic acid, etc., are formed, and these give rise to excessive peristalsis. When the growth is at the pylorus, evacuation of the stomach is hindered, and pain results from tension of that part of the stomach which lies between the pylorus and the advancing peristaltic wave. Should ulceration occur, the fine nerve endings are exposed in the bed of the ulcer, and are irritated by the excessive amount of organic acids which are present in the stomach. This irritation reflexly causes an increased peristalsis and very severe pain. In the latter case the *modus operandi* of pain production is exactly as in ulcer. Mansell Moullin, while he recognizes the increase in peristalsis, however thinks that the pain of carcinoma is due to a hyperemia of the peritoneum, which causes it to become more sensitive and to react to peristaltic traction by pain production.

(2) *Lymphangitis.*—This is very frequent in gastric carcinoma, and, according to Lennander and others, is the cause of the pain felt in this condition. They hold that the inflammation progresses into the mesogastrium until it reaches an area where cerebrospinal nerves are encountered and are irritated, and pain is produced. Naturally, when the inflammation is extending backward along the lymph paths, the lymph glands would be involved and become larger. Pressure may then be exerted upon adjacent nerves and give rise to pain. Thus, the pain, radiating around the chest wall, may be caused by pressure on the intercostal nerves from the enlarged glands of the prevertebral area.

(3) *Metastases.*—Metastatic growths undoubtedly cause many of the radiating pains of gastric carcinoma. Metastasis may either precede or follow the inflammatory swelling of the prevertebral lymph glands, and alone, or in association with it, give rise to the radiating chest and abdominal pains. The left shoulder pain, so often complained of by the patient with gastric carcinoma, may be due to pressure on the acromial nerve by the enlarged lymph gland or glands in the supraclavicular region.

Diagnostic symptoms associated with cancer of the stomach are: in the early stages a simple regurgitation of sour fluids; in later stages the regurgitation is changed to a vomit, and the fluid is of greater quantity, often fermented, and sometimes contains blood and the Boas-Oppler bacillus. If the cancer is well advanced, a definite tumor frequently can be located in the epigastrium. This tumor moves with respiration, and is tender to the touch. In malignant disease of the pylorus bile may be present in the vomitus. This may be accounted for by the lack of tone in the pyloric sphincter, due to the atonic condition of the musculature. The ingestion of food almost immediately starts the pain, which generally persists until the stomach is relieved of its contents by vomiting or by exit through the pylorus. The kind of diet influences the severity of the pain. Indigestible substances or those hard to digest, as cabbage, corn, pork, tough meat, and rye bread, generally are productive of great pain. Left-sided pleurisy is often associated with gastric carcinoma, and frequently gives rise to chest pains.

Pains due to metastases in other organs may follow upon a train of symptoms indicative of gastric carcinoma; these pains are most frequently located in the epigastrium, and are not influenced by the ingestion of food.

Schmidt claims that in many cases of tuberculosis with dyspepsia the symptoms could be confused with those of gastric carcinoma, because of the loss of weight, anorexia, and epigastric pain due to coughing.

Perigastric Adhesions.— In cases of long-continued inflammation and lymphangitis of the stomach, such as result from gastritis or from ulcer, the pain which is present is, in almost all cases, due to the adhesions which join the stomach to the adjacent viscera. Adhesions existing between the anterior gastric wall, or pylorus, and the parietal peritoneum are the most painful. A factor of importance in the diagnosis of gastric-adhesion pain is that the pain is made worse by change of position, though in the change of position the location of the pain remains the same. Another factor is that it is worse during active peristalsis or distention of the stomach, and is always located in the same area.

Palpation of the abdominal wall and stomach, as a means of localizing the lesions, is useful, for if adhesions are present pressure made in an upward direction from the lower border of the stomach will increase the pain. If the adhesions are to the right or are on the anterior border, pressure made over the epigastrium will cause pain to shoot out from the right over the border of the stomach. If the adhesions are on the posterior gastric wall pressure over the first and second lumbar vertebræ will often cause pain. When the adhesions are between the anterior abdominal wall and the stomach they are very apt to be confused with gastric ulcer (Cumston, 580). Erdman (581) claims that in gastric adhesions no pain is complained of on any movement of the stomach, only a sense of soreness being present. This is contrary to the opinion of the majority of observers.

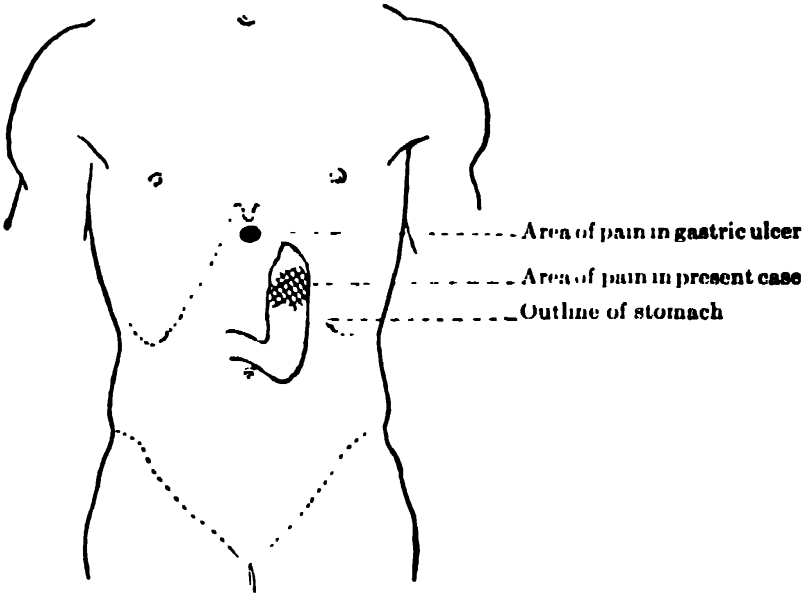

FIG. 98.—POINT OF TENDERNESS AND THE AREA OF PAIN IN A CASE OF PERIGASTRIC ADHESIONS.

W. Langdon Brown (583) describes a pain situated just below the costal arch and a little to the left of the middle line. Its onset had no relationship to the ingestion of food, but came on as soon as the direct posture was assumed. On operation a firm adhesion to the anterior abdominal wall, about the size of a half crown, was found midway between the greater and lesser curvatures, and rather nearer the cardiac than the pyloric orifice.

The stomach was in direct contact with the anterior abdominal wall. In some cases adhesions between the anterior abdominal wall and the anterior wall of the stomach may cause such severe symptoms that the patient is unable to assume the upright position and remains bent forward (Gilbride, 582).

The following points, as given by Brown, are indicative of perigastric adhesions:

(1) The symptoms have not infrequently been preceded by those which are more characteristic of gastric ulcer or of gall-stone colic; (2) local tenderness is very frequent; (3) pain is greatly influenced by the position of the patient; (4) vomiting, as a rule, is not present; (5) careful dieting does not seem to have much influence on the pain. Pressure over the last two dorsal vertebræ and the first and second lumbar frequently causes pain in adhesions of the posterior gastric wall.

REFERRED PAINS CONFUSED WITH THOSE OF GASTRIC ORIGIN

After a consideration of the direct pains of gastric origin it is necessary to consider those referred and reflected pains that are so often confused with them. These pains are of nervous origin and are due to neuralgia of the sympathetic or of the intercostals; or are projected pains from cord lesions, or are referred or reflected pains from lesions in organs at a distance.

Neuralgia of the sympathetic or of the vagus, which supply the stomach, may occur just the same as does neuralgia of other nerves in other parts of the body. In neuralgia of the vagus nerve the pain is felt in the area of distribution of the sensory fibers of the affected nerve, or is reflected through communicating branches into the distribution area of the sensory part of related nerves. In involvement of the sympathetic, pain is not felt in the area of distribution of the sympathetic fibers, but the irritation is referred to the cord and thence outward into the distribution area of those spinal nerves whose cord-associated neurons have been stimulated.

This neuralgic condition may exist in either one of the gastric nerves, namely, the vagi and the splanchnics. Both may be subject to disorders causing pain. Schmidt reports a case of vagus neuralgia in which pressure in the left external auditory meatus, or irritation over the painful area with a combination of oil of mustard, menthol, and liquid petrolatum, caused the pain to cease.

The pain of intercostal neuralgia is often confused with that arising from the stomach, but, though the pain may be present in the epigastrium, the diagnosis is easy if it is remembered that in intercostal neuralgia there are tender points in the corresponding intercostal spaces, one or two inches from the spine. These are absent in gastralgia. The pain of intercostal neuralgia is also increased on exposure to cold and to draughts.

Lesions of the cord are often mistaken for gastric disorders because of the projected pain which they occasion; but here there is an absence of gastric symptoms; the pain is generally bilateral, and there are other well-defined symptoms of the nervous disorder. It is claimed by Schmidt that gastric crises (tabes) often have a tendency to a left-sided localization. (Schmidt, 584, p. 101.)

It is also characteristic of tabes that at the time of the epigastric pains, or crises, there is almost always an uninterrupted and exceedingly painful vomiting. The vomit consists at first of food, later of a mucous fluid which is sometimes mixed with bile or tinged with blood. This is accompanied by marked nausea and vertigo, as well as by cardialgic pains, which at times reach a terrible degree of intensity. These attacks may appear at the very beginning of the disease.

Referred pains to the epigastrium are often due to the appendix, uterus, ovaries, gall-bladder, in some cases, to aortic aneurysm, the pancreas, spleen, even umbilical hernia, and Addison's disease.

CHAPTER XXIV

INTESTINAL PAIN

GENERAL CONSIDERATIONS

The value of pain in the diagnosis of intestinal lesions is of more moment than is apparent from a cursory view of the subject. In a patient in whose case the diagnosis is obscure the correct interpretation of the pain manifestation is of vast importance, and may be the means of eliciting the cause of otherwise inexplicable symptoms, and lead to effective treatment.

For convenience the intestine is divided into two portions, namely, the large and small, both of which are united to the body wall by a mesentery. The mesentery attached to the large bowel is not as long nor as mobile as that attached to the short one, so that when the large intestine is distended beyond its normal limit it gives rise to more pain than does a proportionate increase in distention of the small intestine.

Etiology of Pain.– The researches of Mackenzie, Lennander, and well-known anatomists, physiologists, and surgeons have shown that the intestinal mucosa, of itself, is insensitive to ordinary forms of tactile sensibility; that it can be pinched, punched, and resected without producing pain, provided no traction is made upon the mesentery and that no tension is exerted on the muscular walls. There are, therefore, two distinct types of intestinal pain– possibly more. The one due to the pull and drag upon the adjacent peritoneal structures; the other a true intestinal pain due to tension within the muscular structures. This latter type of pain—deep sensibility pain—has often been misinterpreted. As has been stated, the adequate stimuli for visceral pain are not those of the ordinary tactile or thermal types so well known for the skin and mucous surfaces. The adequate stimulus here is tension and when the threshold of deep pressure sensibility is reached pain results. It must be recalled that while tactile, thermal, chemical, and possibly other forms of stimuli may not be capable of exciting specific receptors in the intestinal canal, nevertheless they are capable of inducing motor reflex activities causing contraction, and that contractions which cause tension to mount to the deep sensibility threshold result in pain. Deep sensibility sensations may be transmitted by the sympathetic fibers.

However, many do not believe that pain as a sensory entity exists in the intestine. Since these hold that pain is not present in the intestines, they must be asked how and in what manner it is produced, since it undoubtedly is felt in lesions of the intestinal viscera. It was formerly held that pain, as pain sensation, is not transmitted by sympathetic fibers; therefore, the only nerve fibers that could transmit pain directly were the fibers of the cerebrospinal system, which, except the vagus (Bayliss and Starling), are not in any way associated directly with the intestinal viscera, although, in some cases, they are indirectly associated through the phrenic, the lower six intercostals, the lumbar, the sacral nerves, and the splanchnics (Lennander). The sympathetic cannot carry stimuli which may be directly interpreted as painful, but do carry stimuli which are reflected to the body wall and are there felt as pain. According to Lennander, "all painful sensations within the abdominal cavity are transmitted only by means of the parietal peritoneum and its subserous layer, both of which are richly supplied with cerebrospinal nerves around the whole of the abdominal cavity, possibly with the exception of the small area in front of the vertebral column, lying below the crura of the diaphragm and between the two chains of sympathetic nerves." Here, he says, as far as he is aware, no cerebrospinal nerves have as yet been demonstrated. On a few occasions he has observed that within this area the patient does not respond to hard pressure with finger or instrument, nor, furthermore, does he experience any sensation when a small portion of the mesenteric attachment at this point is put on the stretch. This coincides somewhat closely with the views of Mackenzie, that it is only the sub-serous peritoneal layer which is the cause of pain in intraabdominal lesions. However, these elaborate hypotheses devised by Mackenzie and Lennander, to show why pain was felt in intestinal disorders when they were insensitive to tactile sensibility, have all been swept away by the recognition of the fact that the adequate stimulus for intestinal pain production is tension and not the well-known pain-producing stimuli, touch, heat, pressure, etc., of the skin and the mucous membranes; that the intestinal pain belongs to the type of deep sensibility pain and that it is conveyed through the sympathetic nerve fibers. It had been held for a long time that the sympathetic nervous system carried no pain fibers. Langley and Head hold the contrary view. In any case, these sensations are conveyed to the cord, where they stimulate certain cord segments, and thus cause pain to be referred to the somatic distribution area of these segments or zones.[1]

That pulling and stretching of the mesentery can cause pain is shown by Lennander, who, in describing an operation, says that "pain was occasioned by the placing or removal of gauze compresses between the viscera and the parietal peritoneum, by the dragging forward of the cecum, of the appendix vermiformis, or of any other organ whose normal attachment to the anterior abdominal wall was put on the stretch." The same principle applies to the stretching of abdominal adhesions, which may connect the viscera with the anterior abdominal wall. On the other hand, should a compress lie between the viscera without coming into contact with the anterior abdominal wall the patient experi-

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[1] Wilms (33b) believes that only the spinal nerves can convey pain sensation. He says that the intestine of man has no sensory nerves, but that in the mesentery the sensory nerves run almost to the intestines. The pain in intestinal colic is caused by a pull on these nerve terminals and, therefore, the pain is referred to the area where the mesentery is attached to the vertebra—rather that the pain is referred out along the peripheral distribution of the spinal nerves connected with the same segment of the cord as are the nerves from the mesentery, so that, when irritation occurs in their distribution area, the sensation (pain) is referred along the body wall.

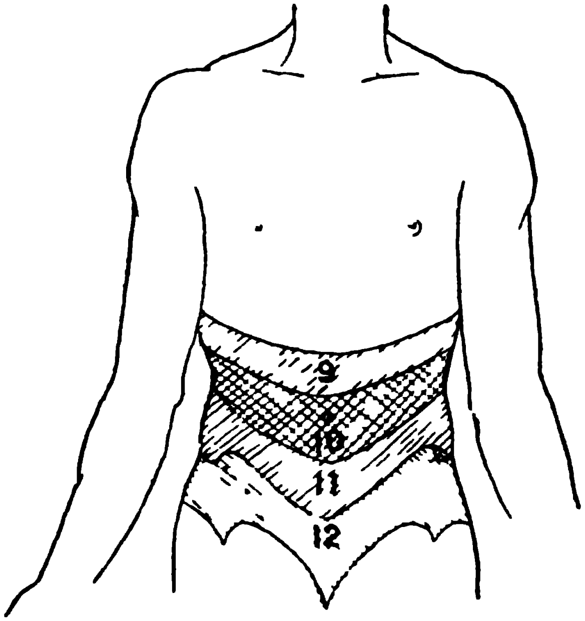

FIG. 99.—ANTERIOR VIEW OF AREAS OF REFERRED PAIN IN INTESTINAL DISEASES.

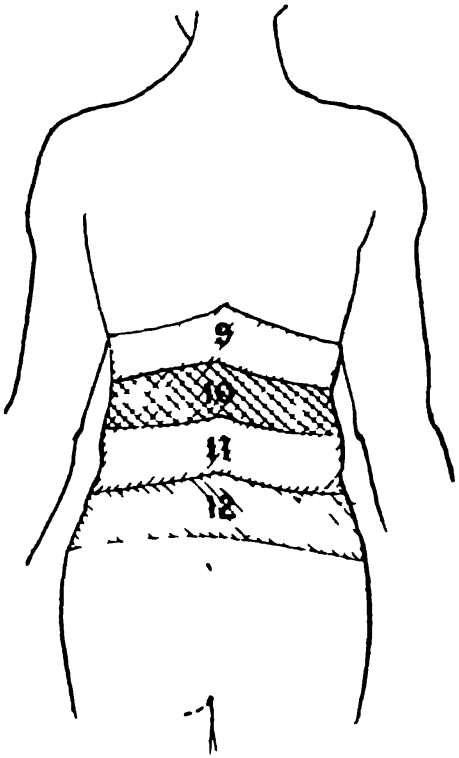

FIG. 100.—POSTERIOR VIEW OF AREAS OF REFERRED PAIN IN INTESTINAL DISEASES.

ences no sensation when it is removed. Similarly no pain attends the stretching or breaking up of adhesions which have no connection with the abdominal parietes. The parietal peritoneum along the thoracic aperture and around the foramen of Winslow is especially sensitive to stretching and displacement. Robinson (265) reports the absence of cutaneous hyperalgesia in cases of acute intestinal obstruction.

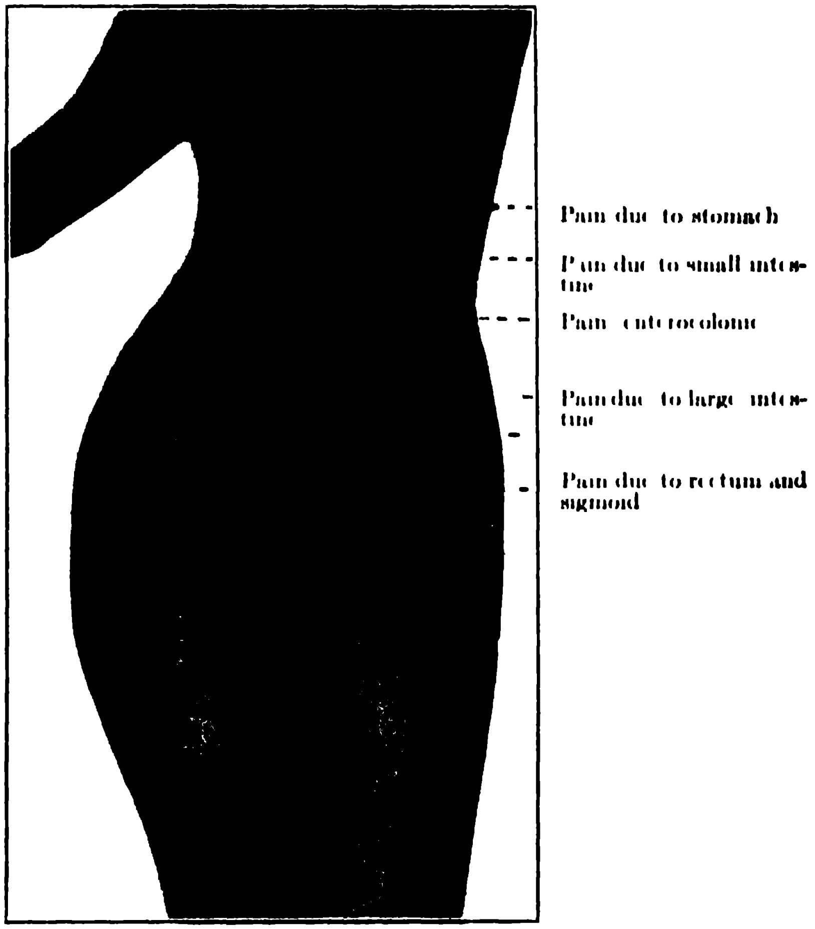
Pain due to stomach
Pain due to small intestine
Pain enterocolonic
Pain due to large intestine
Pain due to rectum and sigmoid

FIG. 101.—POINTS TO WHICH PAIN IS REFERRED IN LESIONS OF DIFFERENT PARTS OF INTESTINAL TRACT.

The pain of intestinal origin is very imperfectly localized. The reflex hyperesthesial and abdominal projections are better capable of exact localization. They are therefore of great practical value.

If the lesions are of the small intestine the pain is reflected to the anterior abdominal wall in the interval between the umbilicus and the ensiform; if the disturbance is in the large intestine the pain is felt slightly below the umbilicus. In lesions of the rectum and sigmoid it is felt directly above the pubes. The drawing on the previous page, according to Mackenzie, shows his deductions.

A peculiarity of referred somatic pain is that it seldom is felt in the posterior distribution of the dorsal segments, but is almost invariably present in the anterior distribution area. When reflected somatic pain is present in the posterior distribution, it is always present at the same time in the anterior, though the anterior distribution may be present without the posterior involvement.

Wilson (896) advances a hypothesis which, because of its novelty, is quoted here. He says: "Muscle fiber has two opposing types of activity: (1) the contractile activity, due to contraction of the longitudinal elements of the fibers; and (2) the expansile activity, due to contraction of the transverse elements of the fibers, thus causing them to lengthen. Some pathological elements cause the bowel to expand instead of contract, so that there is an active expansion." He thinks that the rigid arch of the abdomen in peritonitis is due to the expansile activity of the muscle fibers in the gut, for he cannot understand how a contraction of the abdominal muscles will produce an arched instead of a straight line. He also claims that in some cases in which the irritation causes a stimulation of the expansile activity a conflict takes place between the two tendencies, resulting in pain, the so-called colic.

Pain may also be referred to the peripheral distribution of the genitocrural, the ilioinguinal, the iliohypogastric, the external cutaneous, and the accessory nerve to the external cutaneous. In these cases the pain is due to pressure made upon these nerves by increase in size of the cecum or of the sigmoid. It is very frequent in new growths of these organs.

Besides the above causes of pain, due to intestinal lesions, we have two others which are generally forgotten, or, if not forgotten, are thought to be of such slight importance that they are not mentioned. These are the pain due to pressure upon adjacent nerves by lymphatic gland enlargement, such as is found in tuberculous intestinal lesions and leukemia, and, second, the pain due to irritation of the large ganglia of the sympathetic. The latter, either by direct involvement in the inflammatory process or by irritation from stimuli received through peripheral branches, become supersensitive and react abnormally to normal stimuli.

By many observers the origin of the epigastric pain which is felt in so many intraabdominal lesions is supposed to be due to an irritation of the solar plexus. This is undoubtedly erroneous, for it seems that the solar plexus has a direct connection with pain production, only in so far as it acts as a clearing house for stimuli received through the different abdominal sympathetic ganglia. From the solar plexus are derived the sympathetic fibers which connect with the sixth to the ninth visceral segments of the cord. Irritation to these fibers, arising either independently in the fibers or transmitted from the ganglia, is carried to the cord, whence it is referred to the body wall as pain. The maximum point of tenderness of the seventh dorsal segment is in the epigastrium. Since it is generally in the area of maximum tenderness that subjective pain is felt, it is in this area that pain associated with most of the abdominal lesions is perceived.

Should intestinal disease be suspected as a cause of abdominal pain there are certain characteristics of the pain-symptoms that lead to a fairly definite decision, not only as to the involvement of the intestine, but even to the segment of the bowel which is involved. The characteristics aiding in the diagnosis are the location of the pain, its type, manner of onset, variation (depending upon the position of patient), duration, result, and history of the pain, and the associated symptoms.

Location of the Pain.---Nearly all painful lesions of the intestine first betoken their presence by circum-umbilical pain. In appendicitis this is very common, but, as the pathology progresses, the site of the pain is changed from the umbilical region to the right lower quadrant of the abdomen. In diseases of the large intestine the pain is generally felt below the umbilicus, while in those of the small intestine the pain is generally located above. A peculiar characteristic, and one that is of great value in diagnosis, is that in diseases of the large bowel pressure on the abdomen, over the site of the colon (which, in its transverse division, is above the umbilicus, and in its ascending and descending divisions to either side of it), will produce pain in the mid-abdominal zone without, in many cases, producing any pain at the point of pressure. In lesions of the small intestine the contrary holds true, for pressure in the area below the umbilicus generally causes pain in the supra-umbilical zone. If the pain that is felt closely resembles that produced by stomach disorders, as is so often the case in duodenal ulcer, and an examination of the stomach fails to reveal any abnormality, the duodenum should then be suspected as the cause of the pain. It is very common for the duodenum, because of its close nervous relationship with the stomach, to produce symptoms similar to those of gastric disturbances. In some cases the pain of intestinal disease is felt in the back, in one or the other lumbar region. Pain in the back generally alternates with the pain of the anterior abdominal wall. As a rule both are not coincident.

Visceral pain depends for its localization largely upon the fixity or the mobility of the organ affected. The more fixed the viscera, as a rule, the more constant the pain. Thus in the mobile and freely moving small intestine the localization is diffuse, and centralizes chiefly about the umbilicus. In the movable parts of the colon pain is felt between the umbilicus and the pubes. In diseases of the duodenum, the last few inches of the ileum and the ascending and descending colon, and in lesions at the hepatic, splenic, and pelvirectal flexures the pain is felt at the points where these structures are joined to the abdominal wall.

Type of the Pain.—A sudden abdominal pain, associated with vomiting, should always suggest an acute abdominal lesion, such as an obstruction by volvulus, bands, strangulated hernia, foreign body, intussusception, and appendicitis. If the vomiting persists, and the pain becomes of a gradually increasing intensity and spreads over a wider area, it is certain that the intestinal lesion is one of increasing gravity. At the same time, should a chill and rise of temperature accompany or precede these symptoms, it is very likely that the trouble is of an inflammatory nature. If the pain is paroxysmal, with no rise of temperature, colic should be thought of, or else an obstruction should be sought. Likewise, if the pain is of a griping character, and is accompanied by diarrhea, enteritis is most probable. It is characteristic of patients whose pain is due to lesions of the lower bowel that they try to ease it by lying with the back bent and the lower limbs flexed. In case the pain is due to a spasm of the intestinal muscles, pressure and heat over the area affected will often give relief. If the lesion is inflammatory, heat and pressure increase the pain, while cold often produces ease and comfort.

Manner of Onset.- Intestinal pain may be gradual or sudden in its onset. When the onset is gradual with a slow increase in the intensity, we know that the lesion is gradually increasing in severity. The most common lesions which have gradually increasing pain are those of an inflammatory origin, such as appendicitis, enteritis, and those tuberculous lesions causing peritoneal irritation, especially if these are of rapid progress. Should the onset be sudden it generally indicates a rather severe and unusual derangement of the intestinal viscera, such as may occur from knots, kinks, and intussusception. Generally in these lesions, and especially in all lesions which produce obstruction, enlargement of the bowel proximal to the site of the obstruction occurs, so that palpation of the abdomen will disclose a tumor mass, tympanitic on percussion. If in a case of acute intestinal pain, tumor is absent and palpation reveals an area of exquisite sensitiveness, gradually increasing in extent, it frequently is an indication of a perforation of the bowel. This is especially true in those who are suffering from intestinal tuberculosis or from typhoid fever. Should the pain be acute in onset, and be relieved by vomiting, it indicates an intestinal spasm. This spasm usually is caused by the collection of gas due to fermentation or putrefaction of indigestible food, and often is followed by a diarrhea which lasts for a day or two. Should acute pain occur, followed by vomiting which finally becomes stercoraceous, it indicates an obstruction which, unless relieved, is sure to cause the patient's death.

In those obstructive lesions in which a tumor formation is present auscultation reveals exaggerated peristalsis over the tumor mass, with absent peristalsis below it in the area where the intestines are collapsed. In these conditions pain is also very common after eating, coming on from one to seven hours after the ingestion of food. Should it come on immediately after eating, it is due to the stimulation of intestinal peristalsis by the entrance of food into the stomach.

Relation of the Position of the Patient to the Pain.—If the pain varies in intensity, depending upon the position of the patient, inflammatory lesions, either acute or chronic, should be sought. Change of position sometimes causes the most pain, especially after adhesions have formed. The pain is greatest in that position in which the abdominal parietes are dragged upon by the adherent bowel, and is always localized to the site of the lesion. Colics are generally indicated by great restlessness and activity of the patient, who often clasps his hands over the abdomen and exerts pressure upon it; on the contrary, inflammatory lesions are generally indicated by the patient assuming a position in which the intraabdominal pressure is lessened. To do this, he lies flat on his back with his knees drawn up. In a case of inguinal or femoral hernia the lower limbs are flexed and at the same time rotated inward.

Relation of the Ingestion of Food to the Pain.—There are three periods in which after the ingestion of food intestinal pain occurs:

(1) The first period follows immediately after eating, and lasts for a varying length of time. It is due to the excitation of intestinal peristalsis by the entrance of food into the stomach, and when present is a fairly good indication of an inflammatory lesion in the bowel.

(2) The second comes on about one or two hours after eating, and persists for a couple of hours. It indicates a duodenal involvement, often an ulcer, or perhaps an inflammation. The two hours mark the duration of the gastric digestion, and time the beginning of the passage of the food from the stomach into the

duodenum. Pain may also be present immediately after the ingestion of food, but this pain only persists for a short time, and is then followed by the duodenal pain. The presence of adhesions around the duodenum, following common duct or gall-bladder disease, will also give rise to this type of pain.

(3) When the pain is delayed, until four to seven hours or longer have elapsed after the ingestion of food, it is a sign that the trouble is low in the bowel. Appendiceal pain occurs from four to seven hours after eating, and is very prone to come on about midnight, provided the evening meal is taken around six or seven o'clock. If it occurs at a longer interval than seven hours it is an indication that the lesion is in the large intestine. This is especially true if rather indigestible foods, as stewed cabbage, etc., have been eaten.

Duration of Pain.— A pain of short duration, pathologically speaking, is generally of but slight moment, while one of long duration indicates a lesion of more or less severity. The more constant the pain, and the greater its intensity, the more should it merit our attention, not only because of the portent of harm to the patient, but also because of the necessity for the individual's ease and comfort to diagnose and relieve the symptoms as soon as possible after examination has been made and charge of the case has been assumed.

Result and History of the Pain.—A pain that passes off without any untoward result and is of a paroxysmal type generally is due to colic. If the pain is of this character, the different colics, such as hernial, foreign-body colics, volvular colics, and those due to enteritis, should then be quickly passed in mental review. Pancreatic, biliary, urinary, and uterine colic also should not be forgotten. If there be a history of recurring attacks, associated with vomiting and constipation, especially if a rise of temperature and pulse rate is present at the time of the attack, and tenderness on the right side is marked, appendicitis should be suspected. If the attacks are spasmodic, and successively shorter intervals occur between each successive attack, it is, in case of ulcerative lesion of the bowel, an indication that the stenosis, which is the cause of the attacks, is progressing, and that gradually the lumen of the bowel is becoming more constricted.

Tenderness is of two types: *(a)* superficial, and (b) deep. The *superficial tenderness* often exists in the form of a hyperalgesia. This hyperalgesia is in well-defined zones, which have been described earlier in the chapter. *Deep tenderness* frequently is present over the area of the bowel involved, and is due to localized peritoneal inflammation. When pain is felt at the site of the irritation it is called direct pain or tenderness. When it is felt in other areas it is called indirect pain or tenderness.

In the diagnosis of intraabdominal lesions, especially those of the alimentary tract, tenderness may be of much importance. Where the tenderness is direct it is due to inflammatory irritation of the parietal peritoneum or of its subserous layer. An area in which *direct pain* is present is tender only when, on palpation, the pressure exerted is strong enough to irritate the peritoneal subserous layer. An area in which the pain is indirect (hyperalgesia) is painful upon the slightest irritation. Even the drawing of the tip of the finger or of the head of a pin across the surface is extremely painful. This very marked superficial tenderness may or may not be found at the point where the deep mural tenderness, or tenderness on deep pressure would indicate the site of the lesion.

Symptoms Associated with the Pain.—Symptoms associated with intestinal pain are: vomiting, diarrhea, tumor (tympanitic or dull on percussion), tympany, generalized or local, obstipation, shock and collapse, rise or fall of temperature, changes in pulse or respiration, diaphragmatic breathing, and inguinal glandular involvement.

Vomiting is a symptom which, in obstructive disorders of the intestine, follows shortly after the initial pain. The longer it is in making its appearance the lower is the lesion in the bowel. In nearly all intestinal lesions the vomitus consists at first of the contents of the stomach, then, as the reversed peristalsis carries the food from the lower segments of the bowel, it becomes more and more fecal in character. From the time of the onset of the vomiting to that of the appearance of the fecal material (if the obstruction is low in the bowel), a fairly good estimate of the location of the lesion can be made.

Diarrhea, following in a few hours the onset of a pain, generally indicates an enteritis, the pain being but an indication of the bowel spasm which is present. Should diarrhea follow at a considerable interval after the beginning of the attack, it is likely that obstruction of the bowel is present, and has progressed to such an extent that peritonitis has been produced. It must be remembered, however, that diarrhea is not an invariable accompaniment of enteric obstruction, constipation being present in all cases in the early stages, and often persisting until the end. In localized bowel obstruction there is present a tympanitic tumor. If the tumor is in the center, and somewhat to the left of the median line, it indicates that the lesion is probably in the small bowel; while if it is in either flank, the large intestine is very apt to be at fault. A solid tumor associated with tympany may be due either to tuberculosis or to a new growth (benign or malignant); though, generally, neither of these causes any severe or marked pain, and their progress is gradual.

Should *shock and collapse* be associated with severe abdominal pain, it may indicate the rupture of the intestine into the abdominal cavity. The rupture may be due to previous ulcer formation, either typhoidal or tubercular. Typhoid perforation occurs most often during the third week of the disease, and is diagnosed by its characteristic signs; while tubercular intestinal ulcers betoken their presence by special symptoms. Intussusception and volvulus are frequently associated at the time of their occurrence with considerable shock. The rupture of an inflamed appendix causes great shock, and generally occurs only after the disease has been present for a few days. *Temperature, pulse,* and *respiration* are of value in the diagnosis of tuberculosis, typhoid fever, appendicitis, and strangulated hernia. They are but slightly changed in volvulus and hernia. Pain on deep inspiration, and the absence of diaphragmatic breathing are often valuable in the diagnosis of peritonitis originating from a perforated ulcer or a ruptured appendix. *Glandular enlargement* is of but slight diagnostic importance in clearing up the origin and cause of abdominal pains.

LESIONS OF THE INTESTINES CAUSING PAIN

Because of the manner of origin and peculiarities, intestinal neuralgia and colic merit a separate discussion. The lesions of the intestines will be considered in the following order:

(1) Enteralgia.
(2) Neurosis.
(3) Inflammation.
(4) Ulceration.
(5) Adhesions.
(6) Intestinal obstruction.
(7) Diseases of special parts of the intestine, such as: (*a*) appendix; (*b*) colon; (*c*) rectum; (*d*) anus.

Enteralgia.—That irritation which is interpreted as painful may of itself arise in the intestinal walls without an associated inflammatory state is very likely. Reasoning from analogy the terminal nerve filaments in the walls should be subject to irritation by toxic substances. This irritation sets up motor activities which are interpreted as painful. The stimulus (resultant of excessive motor activity) is carried by the sympathetic nerves to the cord, where collaterals of the spinal nerves are involved. This causes reflex hyperalgesia in the abdominal walls. Yet enteralgia, as a pathological entity, is very rare. Pains of other abdominal lesions are frequently mistaken for bowel pain, and the intestine is credited with their production, when it has no association with them. Perhaps even more frequently organic lesions of the intestine are mistaken for enteralgia. How many times appendiceal, gall-duct, and pancreatic-duct colic are mistaken for it! How often does the patient go on for years suffering from distressing symptoms associated with these disorders, when the cause could have been so easily removed, and the individual restored to comfort and happiness! Schmidt, who quotes from Hawkins, evidently mistakes other lesions for enteralgia, for he says that "the pain of enteralgia is central, occurs in short, sharp attacks, quite as severe as a biliary or renal colic, and is equally attended with sweating and collapse." An analysis of the above should convince one that the pain which he describes as enteralgic may be nothing more than a colic of the intestine. In many cases the reason that the generic term enteralgia is applied to abdominal pain colicky in character is that a sufficiently painstaking observation has not been made, and a general and non-specific term has been applied to hide the confusion and diagnostic ignorance of the examiner. Enteralgia should be given as a cause of pain only after all other causes have been excluded; and even then it may be possible that some undiscovered cause, such as local irritative lesions of the musculature, may be present. Besides the myalgic origin enteralgia may be caused by some such similar change as produces neuralgia in the cerebrospinal nerves, and we have, as it were, a neuralgia of the sympathetic. When a probable enteralgic pain is present, without any apparent lesion, the patient's general condition should be carefully studied, to find out if any of the disturbances which are known to produce neuralgia are present. If they are found a tentative diagnosis of intestinal neuralgia may be made until something more definite is discovered.

Pain Due to Functional Disturbances.—The functional disturbances of the intestine producing pain are either secretory or motor.

SECRETORY DISTURBANCES.—That it is possible for secretory derangement of the intestine to cause pain cannot be disputed. The disturbance that causes the most pain is a hyper- not a hyposecretion. It must be conceded, however, that an oversecretion of intestinal juices cannot of itself cause pain, unless there is associated with it some local lesion causing either an inflammation or a circumscribed spasm. When the bowel is stimulated on its internal surface by a local irritant it reacts by a hypersecretion of mucus. This mucus, in its passage down the bowel, becomes rolled into balls, or else adheres to the intestinal wall, so that a greater than normal contraction of the musculature of the intestine is necessary to force it on. Thus spasm, with its resulting pain, is produced. It is not known whether a change in the chemical composition of the intestinal secretion can so occur that the secretion may of itself become irritating.

MOTOR DISTURBANCES. ENTEROSPASM. — Motor disorders, such as spasm of the intestine, are a potent cause of pain. The spasms are due to some local irritative lesion in the bowels or are the result of referred stimuli. The local cause produces a contraction, restricted, as a general rule, to a small area of the bowel; while the contraction spasm, due to a central stimulation, may extend over a considerable section of the bowel. These referred stimuli may result from some disorder of the sympathetic nerves or of their ganglia, or may possibly be due to a lesion in the cerebrospinal system. Such causative factors are found in neurasthenia, either of the sympathetic or of the cerebrospinal type.

The local lesions causing intestinal spasm are most frequently the result of irritation from undigested food, irritative poisons, and foreign bodies. The spasm resulting from this irritation gradually progresses downward, following in its course the descent of the irritating substance. Likewise the pain gradually moves from the epigastrium down over the anterior abdominal wall, until it becomes localized in the suprapubic region. In other cases the irritation may be localized and non-progressive, and the pain is stationary. When such a condition is present inflammation or ulceration is most commonly the cause.

The pain of enterospasm is divided into two classes: (*a*) primary and (*b*) secondary.

(A) The *primary pain* is due to two causes: (1) the pressure made by the contracting muscular walls upon the nerves terminating between the muscle bundles. Lennander's experiment on the intestine with electrical stimuli, which caused contraction and no pain, is non-conclusive, as the adequate stimulus was absent, and the contraction one of an entirely different kind than that which normally is present in the intestines.

(2) The pull and drag exerted upon the mesentery by irregularities in the size of the bowel.

(B) *Secondary pain* is due to distention of the bowel proximal to the area of spasm. It is of the ordinary, colicky type, its duration depending upon the kind and manner of the irritation. Should the irritation be of a transient nature, as is found in disturbances due to the passage of indigestible food, the pain is intermittent and varies in location, though it constantly progresses toward the lower part of the abdomen. Should the lesion be organic the pain is permanently localized and is not progressive, but remains at the point related to the bowel proximal to the point at which the intestinal distention begins. The colon, owing to its being most exposed to irritation, is most frequently the part of the bowel involved in the spasm. In mucous colitis the attack is typical (see Colon).

In a case reported by Hawkins and quoted by Maylard [1] a good description of colon spasm is given: "In this patient attacks came on once in about three or four years. They began as a constipation, which was difficult to relieve; distention ensued, and with it pain and vomiting. The pain was aggravated by the taking of food and by defecation. At the operation, which was performed for the relief of this condition, two areas of contraction spasm, without any associated lesions, were found. The first was at the junction of the descending colon and the sigmoid flexure. The second was in the small intestine. Both areas showed a spasm of the musculature of such magnitude that nothing could be passed through the lumen of the bowel. In both the narrowed part of the bowel passed abruptly into the normal parts above and below."

That such a localized spasm occurs is known to every practitioner of medicine. Many and many a patient complains of fleeting, colicky, abdominal pain, persisting off and on for years. Operation, should it be undertaken, reveals conditions somewhat like those described above, or shows nothing, in which case the appendix is often blamed, and sometimes rightly, for many cases of colic owe their origin to a fibroid appendix. This, because of its constant irritation, produces abnormal excitability to stimuli in the sympathetic nerves and plexuses which supply it. This excitability, in turn, is communicated to adjacent centers supplying the small intestine, which may also become involved and be thrown into a state of pathological excitability. When they are in this condition, stimuli that ordinarily would produce no reaction may cause pain, or else may reflexly produce spasms of the bowel, which in turn cause pain.

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[1] Herbert P. Hawkins, *British Medical Journal*, January 13, 1906, p. 65.

In some cases, because of generalized abdominal symptoms, enterospasm has been diagnosed as peritonitis. The following, which are present in enterospasm and absent in peritonitis, aid in the diagnosis: (1) The low temperature, pulse, and respiratory rate; (2) the excess of peristalsis, even though the abdomen may be rigid and tender; and (3) the absence of any tendency of the process to increase in severity.

The intestine, because it has a lumen of a fairly constant size, is subject to spasm-pain throughout its entire length. Because of the progressive nature of the spasm, the pain is felt at different points on the abdominal wall, depending upon the part of the intestine which is involved.

In some cases spasmodic musculature contraction of the small bowel occurs without any apparent organic cause, and is due to abnormal functional activity. Those who are subject to these spasms are so sensitive to irritative nervous influences of any kind that the slightest change from the normal may cause a spasmodic contraction of the bowel. This change also may be the result of local changes (slight fermentation) in the intestine (producing a local colic), or may be due to causes acting from a distance, such as exposure to cold drafts, which produce an internal congestion, etc. During bodily fatigue colic is also felt. The bowel contraction in the latter case is probably due to the irritation from the toxic materials circulating in the blood. Excessive heat may also act in the same manner.

All these disorders cause a derangement of intestinal secretion, with consequent fermentation and putrefaction of the intestinal contents. These, in turn, irritate the intestinal mucosa, and this irritation may, in some cases, progress to an active inflammation of the bowel. In any case diarrhea is a frequent accompaniment of this condition. It indicates that the changes in the mucosa and bowel contents act as irritants and cause an excessive contraction and forcible propulsion forward of the bowel contents. However, the only structure particularly affected is the mucosa, which at the time is in a state of weakened resistance. This reduction in resistance is often caused by congestion incidental to the chilling of the body surface, in which a peripheral vasomotor contraction occurs. A similar vasomotor spasm may also be caused by emotional stress, such as is present in anger and extreme joy or dejection.

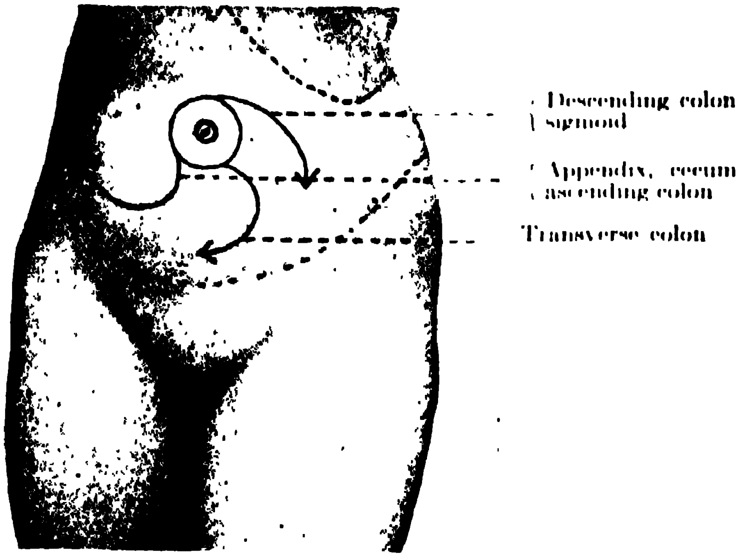


FIG. 102.—PAIN AREAS IN COLONIC COLIC.
Colonic colic begins around the umbilicus and radiates in the directions indicated. The pain of all colics of the colon is generally referred at first around the umbilicus and then later to the area below it. However, if the lesion is in the small bowel the pain is referred above this level.

Colics may be the result of some definite error in diet, such as the eating of indigestible or bad foods. Many persons cannot indulge in whiskey, eat highly spiced foods, nor drink very cold or unsuitable liquids without suffering from colic. People vary somewhat in susceptibility, so that what one person can do or take with immunity will in another cause colic.

Since these attacks of colic often follow a slight indiscretion in diet, possibly such an indiscretion as has occurred many times previously without the production of colic, the patient is apt to ask, and the physician himself should know, the reason of its greater frequency at one time than at another. Its incidence is probably determined by a lessened resistance due to changes in atmospheric conditions, or to removal from one locality to another, especially among those who are not accustomed to traveling. In these the colic is probably due to change in habits and diet. Constipation, with irregular evacuation and overfeeding, is another cause of this colic.

The most reasonable hypotheses as to the cause of colic are those promulgated by Nothnagel, Lennander, and Wilms. Nothnagel says that colic is due to tetanic contraction of intestinal muscles and the anemia produced by this contraction. Lennander claims that in colic in the small intestine the pain is due to pressure against the sensitized parietal peritoneum by the tetanicly contracted loop of small intestine, and that pain from similar peristaltic action of the large intestine is due to traction on its short mesentery. On the other hand, Wilms believes that colic in both the large and small intestines is due to traction on the mesentery. The simple explanation is that the pain of colic is that caused by distention of the muscular walls. It is a special type of pain conveyed by the sympathetic.

Colics generally are sudden in onset. The pain commences around the umbilicus, and thence radiates either above (small intestine) or below (large intestine). The advance of the intestinal spasm is often indicated by changes in the location of the pain. When the spasm is in the small intestine, the pain is above the umbilicus; when in th jejunum, cecum, and appendiceal region, the pain is around the umbilicus; when the large bowel is involved, the pain is below the umbilicus, and, as the spasm progresses toward the rectum and anus, the pain passes down toward the pubes, and becomes lower and lower, until it rests just above the pubes, which is a sign that the bowel contents have reached the sigmoid. The pain now remains stationary until the fecal mass is expelled.

At the time when the colic is at its greatest intensity the pain may be so severe as to cause the patient to cry aloud. He also is very restless, moves constantly about, throws his limbs in all directions, and often lies prone upon the bed or upon the floor. Frequently he presses a pillow or his hands tightly over the abdomen. This seems to relieve the pain (see drawing).

Type of Pain in Colic. The pain may be either intermittent or constant. When intermittent, it becomes lower and lower in the abdomen, and finally ceases on the expulsion of flatus or feces. Should the pain be constant, it shows that the obstruction has become constant and persists at one place. An obstruction of this kind is present in strangulated hernia and intussusception. Intermittency in a colicky pain shows that the obstruction has only been temporary. Such an obstruction may be produced by kinks in the bowel, hardened fecal masses, and the like. Relief of the pain indicates that the obstruction has been overcome. An onward movement of the bowel contents follows, and frequently gives rise to a gurgling. If the obstruction becomes permanent a considerable local distention takes place and causes tumor formation, excessive proximal peristalsis, and an absence of gurgling over the tumor. If pain persists and is accompanied by diarrhea, vomiting, and abdominal tenderness, it is a good indication that inflammatory changes have taken place.

Tenderness is associated with enterospasm. The amount of the tenderness depends on the location and the extent of the bowel involvement. It seems to be the rule that disturbances at either extremity of the small or large intestine give rise to a greater degree of tenderness than do those of the middle part. The tenderness may be indirect, as illustrated in involvement of the transverse colon, where pressure on the abdomen above the umbilicus in the region of the colon will cause pain which is not felt in the area over which the pressure is made, but in the anterior abdominal wall below the umbilicus. If the small intestine is involved, pressure on the abdominal wall, particularly kneading of the abdominal contents, will produce pain in the epigastrium. Local tenderness over the site of a bowel lesion is unusual, unless the abdominal wall (parietal peritoneum and subserous layer) is also involved.

Intestinal colic should be diagnosed from gall-stone, renal, and uterine colic, pyloric spasm, perforation of the bowel, appendicitis, acute pancreatitis, mesenteric embolus, and thrombosis; from the referred pains due to thoracic diseases, as pleurisy, pneumonia; and also from the abdominal crises occurring in certain diseases of the nervous system, as tabes, etc.

Should colic be present without any well-defined bowel lesion, particularly if it occurs in a painter or in one who is accustomed to handle considerable quantities of white lead, it is well to find out if the cramp is due to *plumbism*, pathognomonic signs of which are stippling in the red blood cells, the blue line on the gums, and the wrist drop and foot drop (only occasionally, in the early cases), or other signs of neuritis. Contraction and rigidity of the abdominal muscles occur at the same time as the colic. Inequality of the pupils and tenderness over the nape of the neck are also to be noted.

The colicky pain, as a rule, is felt in the center of the abdomen, in the umbilical region. The sensation is that of the intestine being twisted. Some describe it as a feeling in which it seems as though the bowels were being tied in a knot. During the colic the arterial tension is raised and the pulse is hard. Pal says that the pain of lead colic is due to irritation and constriction of the blood vessels in the intestinal walls, and that this indirectly irritates the sympathetic nerve filaments.

There is also a colic associated with *uremia*. In this condition, beyond the colic, the only other symptoms are those of the uremia.

Inflammation of the Bowel.--Inflammation of the bowel, as a rule, causes little pain as long as there is no excess of motor activity. When active peristalsis occurs there is a well-defined pain; and if the parietal peritoneum is invaded a local tenderness is added which, as a rule, is confined to the involved area of the abdomen. When all the coats of the bowel are involved in the inflammatory process, pain is also reflected to the anterior abdomi-

DIFFERENTIAL DIAGNOSIS OF INTESTINAL COLIC

	INTESTINAL COLIC	RENAL COLIC	GALL-STONE COLIC	UTERINE COLIC
PAIN.	Generally paroxysmal relieved at the time peristalsis produces an onward movement of gas etc. At the time this occurs there is pronounced gurgling	Pain paroxysmal is found in back and is brought on by moving walking etc	Pain is paroxysmal generally follows an indiscretion of diet and is present in the upper abdomen	Pain is in the lower abdomen, is paroxysmal, and is generally associated with a vaginal discharge of blood, frequent at time of menstrual period
RADIATION	To upper or lower abdomen seldom to the back	To lower abdomen and often to the testicle or other end of the penis on the affected side	To the back and under the right shoulder on the right side and up to the clavicle	To thighs external aspect and often to the back
URINE	No change except that indican is frequently found	Often a suppression for some little time and then blood is present	Frequently bile salts and acids are present	No change
VOMITING	Generally present. Vomitus consists of food often undigested and fermenting. Bile may be present	Generally present; consists of the food recently ingested. Bile may be present	Generally present. Vomit is remarkably free from bile	Sometimes present, though not as frequent as in the other colics
TENDERNESS	Direct and indirect is described under intestinal colic	Generally over the kidney lesion and frequently the enlarged kidney can be palpated	Generally over the gall-bladder which often on palpation is found to be enlarged	Not much present
REFERRED-PAIN AREA	That of intestines	That of kidney and ureter	That of the gall-bladder and ducts	That of the uterus.

nal wall, and hyperalgesia is present in the cord zones associated with the intestine.

In inflammatory states of the small intestine entrance of food into the stomach may, by stimulating and increasing the peristalsis, aggravate a pain already present, or initiate one, if none is present. This inter-relationship of the stomach and intestine can be explained upon the hypothesis of the close nervous connection between the two organs, so that a stimulation of gastric peristalsis will likewise cause an increase of intestinal movements.

A confirmatory symptom of value in the diagnosis of inflammation of the bowel is diarrhea, which in acute enteritis or colitis is due to irritation by indigestible or fermenting substances. It is of a foul odor and contains frothy material. In tuberculous enteritis the stool is also foul, and contains blood and shreds of tissue. The diarrheal stool of an inflammatory intestinal lesion (enteritis) is generally acrid, and produces intense irritation around the anus and buttocks, while other diarrheal stools, as a rule, do not excoriate.

Since many of the inflammatory processes are accompanied by fermentative changes in the intestinal canal, it follows that a considerable distention of the bowel from gas frequently is a concomitant symptom. When it occurs, the pain of the distention is engrafted on to that of the inflammatory process.

In some cases of inflammation of the bowels the inflammatory process is very severe and extends to adjacent structures. In this event, because of the involvement of the peritoneum, the subjective pain is associated with considerable local tenderness, and if the cecum or lower end of the ileum should be involved it may be confused with appendicitis. This is all the more likely to happen when the abdominal muscles over these areas are in a state of rigidity, and vomiting and rise of temperature are present. If the inflammation should be in the duodenum the abdominal pain is constant, and there is an increased sensitiveness to pressure in the right hypochondriac region. Duodenitis generally occurs in a patient suffering from an acute gastritis, and in the stools mucus, with or without blood, will be found. Duodenal digestion, according to O'Connell, occurs about three o'clock in the afternoon and two in the morning; therefore, at these times the pain would be most severe.

Ulcers of the Intestine.- The pain in ulcers of the intestine is felt most often in the region of the umbilicus, though the exact localization of the pain depends largely upon whether the lesion is in the small or in the large intestine. In intestinal ulceration the pain is more restricted than in inflammation, and the area or point of tenderness does not move about, as it does both in the latter condition and in colics which are the result of eating indigestible food. The pain of ulcer is frequently accompanied by diarrhea, and occult blood can, in some instances, be demonstrated in the stools. A factor of importance in the diagnosis of the location of the ulcer is in the relationship of the attack of pain to the time of the ingestion of food. Should the pain come on a few hours after eating, the duodenum is most likely to be involved; while if the interval is longer the lesion is apt to be lower in the bowel. When an interval of seven or more hours elapses before the commencement of the pain, the lesion is probably in the large intestine. Another point of importance in diagnosing the location of an ulcer is that the lower it is in the bowel the less is the likelihood of diarrhea. If the pain becomes constant, and is associated with a steadily increasing distention of the intestine, stenosis of the bowel following an ulcer can be diagnosed.

In intestinal ulceration there are, at first, intervals of freedom from pain; but as the bowel lumen becomes narrowed from stricture formation, the intervals of freedom become less and less, until finally the pain is almost constant. This pain is relieved by the passage of the gas present in the occluded bowel. Sometimes rubbing and massage, although they may temporarily increase the pain by the extra intra-intestinal pressure which they produce, will finally cause a passage of the gas and consequent relief. Vomiting also appears, and, as the lumen continues to narrow, gradually becomes worse, until complete obstruction occurs. It is violent, persistent, and stercoraceous.

In ulcer of the intestine, food, particularly that which is hard to digest, may act as a local irritant and increase the contraction of the bowel, with a consequent drag and pull upon the ulcerated area, and thus cause pain. Unripe fruit or vegetables, such as corn and cabbage, are very likely to act as irritating factors.

It is claimed by Schmidt that the application of cold compresses to the abdomen will relieve the pain of intestinal ulcer, while application of heat will increase it.

The pain of ulcers of the intestine generally is not very severe, except when they occur in the duodenum, the sigmoid, or the rectum. Large areas of ulceration in any portion of the bowel are very painful, especially if the ulceration be deep enough to involve the peritoneum. In these cases the areas of local tenderness over the abdomen are proportionate in size to the area of the peritoneum which is involved. In ulceration of the rectum tenesmus is frequent. The different varieties of intestinal ulceration are tuberculous, typhoidal, syphilitic, catarrhal, uremic, trophic ulcers and those following burns.

TUBERCULOUS ULCERS. Non-progressive tuberculous ulceration of the intestine is often painless. Should the ulceration progress pain is present. It may be caused by an associated enteritis, intestinal distention following a stenosis, a fermentation, or peritoneal involvement. Tuberculous ulcers of the duodenum, because of the frequent location of the pain in the epigastrium, are often confused with pyloric spasm or gastric ulcer. A diagnostic point of value between the two is that in pyloric spasm the vomitus never contains bile, while in lesions of the small or large intestine usually it is at least tinged with bile. Diarrhea of a very offensive odor is frequent in tuberculous ulceration. Tubercle bacilli may, in some cases, be found in the stools. Reaction to tuberculin, signs of emaciation, night sweats, and probably some lung involvement can also be detected.

TYPHOIDAL ULCERATION.—Typhoidal ulceration is generally painless, though in typhoid fever it is common for the patient to complain of discomfort in the lower abdomen, and in some cases of tenderness in the right iliac fossa. If the onset of the fever is sudden, there may be generalized body pain and headache. If the development is slow and gradual, and no acute toxic condition is present, the only pain-phenomena may be a zone of tenderness over the tenth or eleventh dorsal visceral segments.

Syphilitic Ulceration.- Syphilitic ulcers of the bowel, as a rule, are painless. Should constant pain in the abdomen occur in a syphilitic, and be accompanied by diarrhea, and, in some cases, by vomiting, a diagnosis of syphilitic intestinal ulcer would be tenable.

Catarrhal Ulceration causes no pain, unless the ulceration is very deep. The same is true of the ulceration the result of uremic and trophic changes.

Ulcers Following Burns. Ulcers following burns are common. They are most frequent in those cases in which the burn is on the abdomen. When they occur they are most likely to be in the duodenum (see *Duodenal Ulcer*), and give rise to no special symptoms, other than those which occur in simple intestinal ulceration. The pain produced by them is apt to be overlooked by the patient, because of the much greater pain which is the direct result of the burn.

Duodenal Ulcers. The pain of duodenal ulcer, like that of gastric ulcer, is paroxysmal. It may be of intense severity, or may be felt merely as a dull discomfort coming at certain intervals following the ingestion of food. In other cases, whether severe or dull, it is more lasting, and sometimes a constant sense of burning or of sharp pain is experienced. This in many cases is relieved by the ingestion of food, therefore it received the name "hunger-pain." The pain is situated to the right of the middle line, and usually a little above the level of the umbilicus. It may radiate toward the right or the left side. Sometimes it is described as having a deep-seated location, being rather unlike the characteristic pain of gastric ulcer in this particular. The time of its appearance varies. It may follow immediately after the taking of food, but most often does not appear or, if it does appear, does not reach its maximum of intensity until two, three, or four hours after eating. The character of the ingested food has a certain relationship to the intensity and occurrence of the pain. Generally speaking, heavy meals occasion a pain of greater severity, although the pain is later in appearance than after light meals. The drinking of copious draughts of water, or the taking of other liquids, such as milk, beer, and wine, or the ingestion of alkalies, may relieve the paroxysm for a time.

Tenderness and rigidity of the abdominal muscles in the right upper segment of the abdomen may be met with. Pressure usually increases the painful paroxysms, although not invariably. That the site of the ulcer bears a relationship to the site of the pain cannot be doubted, though the idea that the pain, localized tenderness, and muscular rigidity occur directly over the site of the ulcer is not tenable.

The pain in duodenal ulcer may be situated in the epigastrium, near the mid-line, and may extend to the right so that it lies between the crest of the ileum and the ribs. In this condition there is also often a tender spot to the right of the lower dorsal vertebra. It is claimed by many (Deaver, among others) that the pain in duodenal ulcer shows a tendency to periodicity, so that it may be absent for long intervals and then occur in an attack of varying intensity. The p[illegible] of duodenal ulcer is increased by moving, eating, or pressure. In many cases there is also present in the abdomen a feeling of gnawing or of boring.

Many theories have been advanced to account for the pain in duodenal ulcer. Three suppositions underlie all these theories, namely: (1) That the HCl, because of its reflex excess of secretion, directly irritates the ulcer and thus causes the pain. But, if this is so, there must be many exceptions, for a duodenal ulcer, without an excess of HCl in the stomach, is frequently found. In fact, it seems that the ulcer is the cause of this increase of secretion, and that the only effect of the excess is that by irritating the surface of the ulcer, it causes a reflex contraction of the pylorus. This leads us to the second supposition, so actively championed by Hertz, (2) that the pain is nothing more than a tension pain, due to localized distention of the stomach walls, the result of excessive stimulation from the HCl. It is known that the pylorus remains closed while the duodenal contents are acid, and that it relaxes only when the contents become alkaline. In duodenal ulcer the duodenal contents are, because of the excessive secretion of HCl in the stomach, seldom, if ever, alkaline. Consequently the stomach is always in a state of hypertension, the result of abnormal peristalsis. This hypertension, however, exists only on the prepyloric portion of the stomach, because it is into this portion that the food is forced by the peristalsis and, being unable to advance because of the closed pylorus, accumulates and causes the increase of tension and the so-called ulcer pain, which has about the same location as that described under pyloric spasm. (3) A third supposition is that advanced by Bier, who holds that a stomach when empty has a tendency to pull to the left, and traction (in case of duodenal ulcer) is made upon the ulcerated area, while, on the contrary, a stomach, when full, is displaced to the right, and the traction is diminished, with a consequent diminution of the pain. Which of these (if any, or if all three) is the active factor in the production of pain in duodenal ulcer is rather difficult to decide, though it seems as though all three may have a more or less important influence.

Distention of the Bowel. Uncomplicated distention of the bowel will cause considerable pain, especially when the distention is sudden in onset, such as is found in acute obstruction, strangulated hernia, etc.

In chronic intestinal distention, pain, as a rule, is not a prominent symptom, and only becomes so when there is a sudden increase in the distention. The pain of distention is relieved by the expulsion of gas, and frequently the patient feels a change in the location of the pain following a gurgling and the forward movement of the gas. Distention of the bowel is denoted also by tympany, localized over the area of the bowel segment involved in the distention. It frequently happens that when the large bowel is distended its segments can be defined by palpation, and if the abdominal wall is fairly thin, peristalsis, if at all active, may be seen. In idiopathic dilatation of the colon (Hirschsprung's disease) pain is usually absent.

Adhesions.—Bands of adhesions, which are a common cause of distention, occur most frequently in connection with the small intestine, and are there a more common cause of obstruction than in the large intestine. They usually do not produce pain unless so placed as to cause, during intestinal digestion or on active movements of the body, a pull or drag upon the parietal peritoneum. They may also cause pain by causing obstruction of the bowel.

Obstruction of the Intestine. Intestinal obstruction is more common in the small than in the large intestine. It may be acute or chronic.

ACUTE OBSTRUCTION.—There are two varieties of pain due to acute bowel obstruction: the primary and the secondary.

Primary pain is sudden in onset, very severe, and of a griping character. It is generally referred to the middle of the abdomen, and is due to the change in the relationship of the parts of the bowel, with a consequent drag or pull upon the mesentery or mesocolon. Following this is the secondary pain. It is more continuous than the primary pain, and, owing to the violent peristalsis of the cut-off bowel, is interrupted with paroxysms of great intensity. Gradually, as the result of paralysis, from exhaustion, or from toxemia due to poisons generated in the obstructed segment, the pain becomes less.

If the pain has a tendency to spread from its primary location and is accompanied by concentric spreading tenderness, it is an indication that the peritoneum has become involved and that a spreading peritonitis has ensued. When this occurs the pain is sharp, stinging, and more constant.

The cause of the bowel obstruction may be one of the following: (A) causes acting external to the bowel, (*a*) twists, volvulus, (*b*) adhesions, (*c*) intussusception, (*d*) hernial bands (see *Hernia*); or (B) those acting within the bowel, as (*a*) contractures, (*b*) fecal contents, (*c*) foreign bodies.

In twists and intussusception the onset is sudden and the pain is most severe. There is also present a well-defined and painful tumor. This tumor, depending upon the part of the intestinal tract which is involved, is located in different parts of the abdomen. If the sigmoid is the part involved, the swelling first begins in the left iliac fossa, and then gradually extends upward, with a central tendency, towards the umbilicus. From the very beginning there are pain and tenderness, which become more severe as the lesion progresses. The pain gradually extends until the entire abdomen is involved.

The pain in intestinal obstruction is due: (1) to inflammation of the peritoneal surfaces and the consequent involvement of the lymph nodes; (2) the traction which the inflated gut exerts on the mesentery and mesocolon; and (3) irritation of the nerves in the affected segment of the bowel by (*a*) pressure from the obstructing agent, (*b*) pressure from violent peristalsis.

In acute intestinal obstruction the history of a previous attack of peritonitis would indicate that the obstruction might be due to adhesions. The pain in these conditions at first is very great, but gradually subsides if the obstruction persists. The temperature and pulse are both variable, though, as a rule, no remarkable change is noted in either. Vomiting, though not constant, generally is an accompaniment of obstruction.

Sudden, acute abdominal pain, periodic in character, associated with the passage of blood per anum, occurring in young children, should always lead to a consideration of intussusception as a cause. Obstruction accompanied by periodic pain generally means that a volvulus is the cause. This gives rise to almost the same symptoms as intussusception, though the tumor has, as a rule, a different shape and location.

In the early stages of intestinal obstruction light pressure upon the abdomen will often give relief. If during the course of the disease the pain suddenly subsides without improvement in the pulse and the general condition, the case is serious. If, after having ceased, the pain again commences and becomes rapidly generalized, it is a sign that a generalized peritonitis has developed.

Chronic Obstruction.—Chronic intestinal obstruction is due to adhesions, contractures, new growths, foreign bodies (gallstones, fecal concretions), and inflammatory processes. In these the development is slow, and extends over long periods. At first there is only a sense of discomfort, which gradually becomes worse until it is merged into pain. This pain is intermittent and occurs in cramp-like paroxysms. These pains arise suddenly, and are relieved as soon as the stagnated fecal matter and gas have been forced beyond the point of obstruction by the pressure from the rear. The patient is also conscious of the "pain" beginning in a certain spot and working in a screw-like fashion up to another spot where it ends (Maylard). If the degree of obstruction suddenly becomes greater the pain immediately increases in intensity, sometimes so markedly and suddenly that the diagnosis of an associated acute obstruction is made. What really happens is that only an exacerbation of an existing condition has occurred. After a time the pain again subsides, owing, perhaps, to fatigue or to relief of the local conditions (Stengel).

Early in the course of intestinal obstruction the pain is mild, paroxysmal and infrequent; but as the obstruction becomes more complete, attacks of pain are more frequent, and are of greater severity. Associated with the pain are tympanitis, vomiting (possibly fecal), visible peristalsis (should the abdominal walls be thin), tumor, which is tympanitic, obstipation, and generally an absence of fever. Previous attacks of localized peritonitis or the history of an abdominal operation will suggest a band or kink of the intestine as a cause of the obstruction. The history of a tumor will suggest pressure and faulty position of an intestinal coil; emaciation in middle life suggests malignant disease; ascites should lead one to suspect tuberculosis (23, p. 220).

Maylard claims that pressure by hardened feces will also cause pain, and he cites a case where severe pain and tenderness were present in the right iliac region, and, on exploratory laparotomy, only hardened feces could be found in the cecum.

Lesions of the sigmoid colon often cause pain of the most racking kind. It is felt at a point usually about two inches to the right of the umbilicus and at the upper part of the iliac fossa at the level of the crest of the ilium.

Overloading of the colon does not seem to be the cause of any special pain. Constipated individuals rarely suffer from pain due to this cause (see Constipation, p. 509).

The presence of indican in the urine is a point of considerable diagnostic importance in locating the site of the obstruction. Should indicanuria be present early in the disease, it is an indication that the obstruction is high up, generally in the small intestine. At the same time, in high obstructions there is a reduction in the quantity of the urine due to the loss of water from vomiting, which is much greater in lesions of the small than in those of the large intestine.

In all cases of obstruction vomiting is constant, and is not accompanied by nausea. The vomitus at first consists of the contents of the stomach, then of the bowel, and finally becomes fecal. The period at which the fecal transition occurs varies, depending upon the segment of bowel involved. The lower the involvement the longer is the fecal vomit in making its appearance. Should the obstruction be as low as the ileum, one or two days may elapse before it appears; *when it does appear it is pathognomonic of obstruction.*

The absence of pain in bowel obstruction may be due to the obstruction being the result of paralysis of a portion of the bowel distal to the obstruction, as in a case reported by Musser. Here, the patient, five days after an operation for intussusception, developed vomiting, which was of increasing frequency and finally became fecal, though no pain was present. On operation the cause of the obstruction was found to be a paralyzed portion of the bowel.

In résumé it may be recalled that obstruction of the bowel may be due to: (1) functional spasm (colic), the result of (*a*) irritation, organic poisons, bacteria, and cathartics, (*b*) inorganic poisons (lead); (2) obstruction of the lumen by (*a*) lodgment of some substance, as enterolith, gall-stones, indigestible or fecal material, foreign bodies, as gall-stones, (*b*) change in the relationship of the parts to each other, as in twists (volvulus), invagination (intussusception), dragging and pulling (hernia); and (*c*) the presence of new growths, which may be inter-, intra-, or extramural.

Volvulus.—Pain in volvulus comes on as a sharp, sudden, severe pain (cramp) in the epigastrium, or in the region of the umbilicus. It is continuous, and at first is of a constant intensity; but as soon as fecal stasis occurs, and distention of the bowel segment proximal to the obstruction occurs, the constant pain is interrupted by a series of cramp-like exacerbations. These exacerbations are indications of the severe contractions taking place in the intestine, in its effort to establish a passage through the obstruction. Gradually, as the obstruction to the circulation in the affected bowel becomes complete, inflammation and gangrene supervene, and a generalized peritonitis, with its accompanying pain and tenderness, occurs. As the gangrene progresses, and the peritonitis becomes more severe, sepsis ensues, and the patient, becoming toxic, complains less and less of pain, until, in a state of somnolency and forgetfulness, the shadow of death hovers over him and he passes into the land of eternal rest. There is no relief for volvulus, unless the knot is reduced either by natural or surgical means.

Associated with the pain of volvulus, as described above, there is also present in the abdomen a rounded tumor mass, either tympanitic or dull on percussion. Obstinate constipation and vomiting are also present, and generally, though not invariably, a rapid pulse. If these symptoms are found, they are of sufficient moment to demand a laparotomy.

Volvulus is most frequent at the sigmoid. When the condition is acute and the obstruction is complete, a distention greater than that which occurs with any other lesion of the bowels rapidly develops. Therefore, when sudden pain is followed by a rapid distention, without signs of peritonitis, volvulus should be considered. It is more frequent in men than in women, but constitutes only about one-fortieth of all cases of intestinal obstruction.

Intussusception.—This is very frequent in infants, and, while pain is undoubtedly pronounced, yet we are not able to make a definite assertion, because the infants, on account of their immature age, are unable to express their distress. Therefore, should evidence of colic occur in a baby (who, as frequently happens, has had a previous diarrhea), followed, within a short time, by the development and gradual increase in size of an elongated tumor, with an associated constipation, a tentative diagnosis of intussusception may be made. If the disorder should happen in those of more mature years, a more detailed account will be given of the onset and the nature of the accompanying pain. Bearing in mind the manner of production of this disorder (the sudden, acute invagination of one part of the bowel into another part, with consequent pull and possible twist of the mesentery), the reason for the sudden acute pain is apparent.

It is commonly stated that the pain in intussusception is directly over the site of the tumor mass, but the fallacy of this is clearly proved in the introductory remarks to this chapter. The pain, which at first is of a well-defined, colicky type, generally is confined to the umbilical region or lies immediately below it. Since the lesion is located most commonly in the cecum and the lower part of the ileum, the pain may finally become localized in the right iliac fossa. This location of the pain can be explained from the fact that, when intussusception occurs, considerable pull is made upon the mesenteric attachments of the ileum and is reflected as pain to the anterior abdominal wall, generally in the region of the umbilicus. As the intussusception progresses an added pull is made upon the cecum, and through it traction is exerted upon the parietal peritoneum, with pain referred to the right iliac fossa, or to the lumbar region on the same side. Later in the disease, owing to restriction of the blood supply and to pressure, the inclosed segment of the bowel becomes necrotic. Inflammation of the proximal segment then occurs, and is communicated to the adjacent peritoneum, with the production of pain. This pain is referred to the area below the umbilicus and across the lower portion of the abdomen. In pain-production the pull and tension on the mesocolon also are of considerable moment.

In intussusception the lumen of the bowel is obstructed, and the forward movement of feces hindered. Backward stasis occurs, and distention of the bowel proximal to the obstruction takes place. This distention then acts as an additional cause of pain-production. In invagination of the ileum into the cecum the etiological relationship of the lesion to the region where the pain is felt is illustrated in the accompanying drawings.

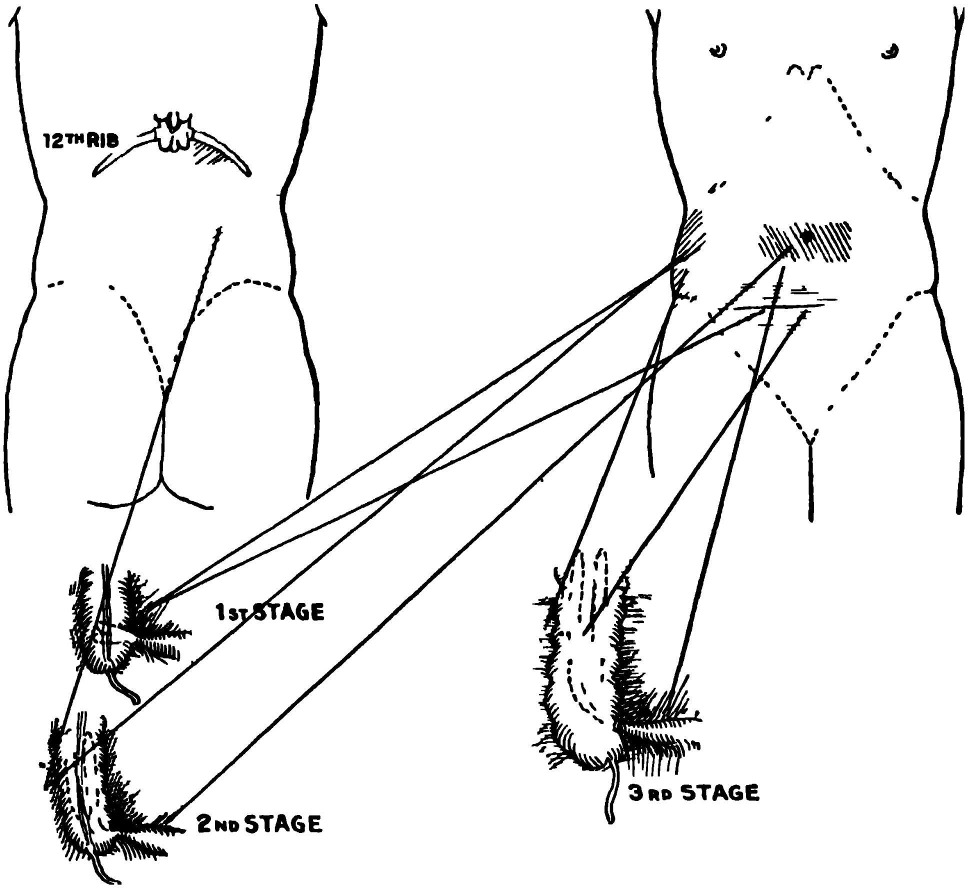


FIG. 103 —PAIN AREAS IN INTUSSUSCEPTION.
First stage Pull upon the mesentery. Second stage Pull on mesentery and traction on parietal peritoneum connected with the cecum and colon. Third stage Inflammation has supervened and pain is also referred to the colon area Figure shows where the pain is felt as the bowel progressively becomes involved in the invagination.

After the intussusceptum has sloughed off, provided the patient survives, there is formed a considerable number of adhesions which, because of their traction, are always a source of annoyance and pain-production. The bowel is also shortened, and the mesentery is constantly on the stretch; and, though in time it may accommodate itself to its changed relations, at first every little (intestinal) distention is noticed much more and produces more pain than it would in a normal subject.

If in the sloughing stage a generalized peritonitis supervenes, the pain becomes much more acute and is diffused over the entire abdomen. Tympanitis also becomes more marked, and tenderness is excessive. In eliciting the tenderness, the pressure exerted upon the abdominal wall must be such that the parietal peritoneum is irritated; pressure must be light but not deep.

That there is a somewhat intimate relationship between peristalsis and the production of pain, and that an absence of peristalsis may lead to an absence of pain, is seen from a case reported by Musser, in which an intussusception was present with an entire absence of pain. At the same time, peristalsis was absent. At operation the intestines were found as limp and as motionless as they are in a cadaver.

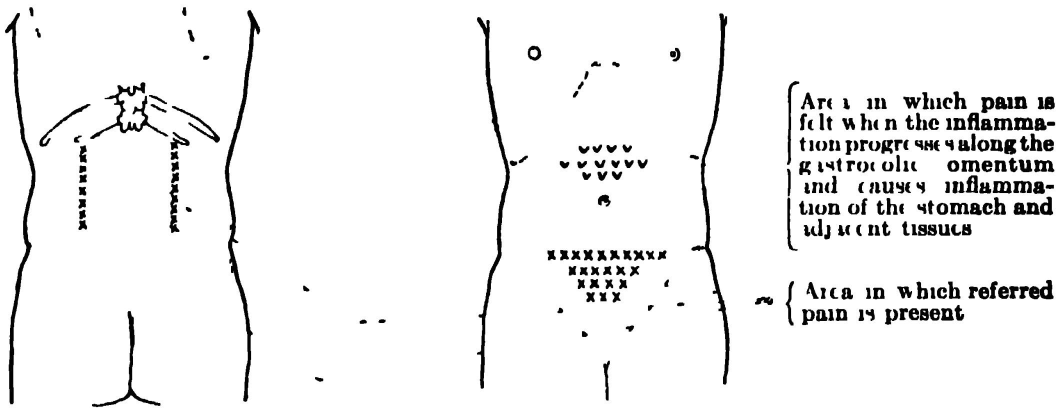
Hernia.—The obstruction due to hernia was considered under hernia of the abdominal wall (q. v.).

New Growths of the Intestine.—New growths of the intestine frequently occur without the production of pain, especially in the early stages. When pain does occur, it is due: (1) to interference with the local circulation, causing congestion, edema, inflammation, and adhesions; (2) obstruction to the bowels; (3) pressure on the nerve filaments in the wall of the bowel or pressure upon adjacent nerves; and (4) dragging and pulling on the mesentery.

Interference with the local circulation does not produce any pain until an active inflammation ensues; then pain becomes a most marked symptom. It is localized to the region over the affected bowel, and is of a peritoneal type. If obstruction to the bowel takes place the pain is of the type described under intestinal obstruction. If it is due to pressure on the nerve filaments in the intestinal wall, the pain may be reflected to the abdominal wall, and be felt in the areas of distribution of the ninth, tenth, eleventh, and twelfth dorsal visceral segments. The higher the point of pressure in the bowel the higher the visceral segment which is involved. If pressure should also be made upon adjacent but extramural nerves, the pain is referred to the area of distribution of these nerves, either in the anterior abdominal wall or in the lower limbs.

If a dragging and pulling on the mesentery occur, aching is felt in the area of distribution of the related dorsal visceral segments.

Pain Due to Colonic Involvement.— The colon is supplied by nerves derived from the superior and inferior mesenteric plexi, which receive their supply from the solar and aortic plexi, respectively. These, in turn, receive their supply from the ninth, tenth, eleventh, and twelfth dorsal segments of the cord (according to Wilson (896), from the seventh dorsal to the second sacral); the segments most commonly involved are the tenth, eleventh, and twelfth dorsal. The pain in colonic diseases seems to be much more pronounced the nearer the lesion is to the anus. When the lesion is high up, the pain is not very severe unless inflammation has extended to the peritoneal coat on either side of the mesentery. If this has occurred, the infiltration may progress to the parietal peritoneum and thus cause pain, which, in lesions of the ascending and descending colon, is felt in the right and left lumbar regions respectively, or, in those of the transverse colon, in the center of the abdomen. Should only traction of the mesocolon occur, the pain is felt in the abdomen in the hypogastric area.



Area in which pain is felt when the inflammation progresses along the gastrocolic omentum and causes inflammation of the stomach and adjacent tissues
Area in which referred pain is present

FIG 104 FIG 105

FIGS. 104 AND 105.—AREAS OF PAIN IN DISEASES OF COLON.

This hypogastric pain comes under the class of reflected pains. It is in the zone of distribution of the eleventh and twelfth dorsal visceral segments. The affections of the colon giving rise to pain are: (1) acute and chronic inflammation, (2) displacements, (3) obstruction, (4) new growths.

INFLAMMATION OF THE COLON.—In inflammation of the colon the pain is referred to the lower abdomen, and, in involvement of the sigmoid flexure, generally to the left side. This reference can only be explained by the fact that, because of the shortness of the mesocolon and its intimate association with the peritoneum of the left side, inflammation of the colon is quickly communicated to the parietal peritoneum of the same side. The increase in local tenderness on this side can also be thus explained.

Inflammatory diseases of the colon causing pain are of two classes: (*a*) acute and (*b*) chronic.

Acute infective states of the colon are always painful, and the pain is of a griping, burning, or boring nature. Pains the result of acute inflammation have a greater tendency to localize themselves to the region of the affected bowel than do the pains produced by chronic disease, which, as a rule, are reflected or referred to distant areas. In inflammatory states of the colon the patient is sometimes conscious of a relief of his pain following movement of the bowels or the passage of flatus. Mild inflammatory states of the colon, as a rule, are not painful; but if the irritation is prolonged, and the inflammation increases and becomes phlegmonous, a septic and generalized bowel involvement or ulceration, with its somewhat mild but persistent symptoms, may occur. In some cases of painful colitis the ingestion of food brings on an attack of pain. This is due, probably, to activity of the colon incited through sympathetic nerve connections.

According to Tuttle, there is in ulcerative colitis a "sudden onset of sharp, lancinating pains in the course of the colon, attended with griping and a tendency to frequent movements of the bowels. These pains last for a short time, then disappear, and the patient may have nothing more of the kind for several days or weeks, when they again occur. They sometimes last an hour or more; at other times they continue for two or three days." If the attack is persistent, pus and blood finally appear in the stools. The attacks are periodical, and the pain, which in the early attacks was not severe, increases in severity with each attack. The amount of the pain bears no relationship to the extent of the ulceration, and is not influenced by the ingestion of food. The cause of the pain seems to be the irritation of the ulcer by the intestinal contents, which incite irregular peristaltic or spasmodic movement of the bowel. In follicular colitis there may be tenderness over the lower end of the spine, with vague pains shooting down the legs.

In *chronic colitis* pain comes on at irregular intervals. It is of a griping character, and generally precedes the passage of a stool consisting chiefly of mucus or of shreds of membrane. After the stool the pain may persist for several days. The onset of the pain bears no relationship to the ingestion of food, nor does it seem to be influenced by diet. Tuttle thinks that the formation of the membrane is the result of a localized increase in the secretion of mucus, this being the result of a localized hyperemia, which, in turn, is due to a slight intussusception or volvulus. When the spasm (localized), which has been the cause of the intussusception or twist, relaxes, the mucus or membrane which has formed is rapidly discharged. The patient, because of the synchronicity, associates the passage of the membrane with the relief of the pain.

Pain may be produced by spasm of the colon without any inflammatory lesion at the same time. Schutz thinks that these cases are most probably primary neuroses. Any systemic crisis, such as that occurring at the menstrual period, may bring them on. The pains occur as cramps in the sides and across the abdomen, at first only at stool, but gradually they become more constant and are interrupted by exacerbations of agonizing intensity. Constipation is pronounced. Loss of appetite, associated with nausea, is present. This condition is found usually in those of anemic and neuropathic tendencies. The lower in the colon the disease is located the greater is the tendency to pain-production. The reason for this is that filaments of the cerebrospinal nerves are distributed to the lower part of the colon, so that, when this part is involved, pressure will be exerted upon these nerves and pain will be produced in the area of their distribution. It is for this reason that in diseases of the sigmoid flexure of the colon pain has a tendency to be localized in the left lower abdominal quadrant. In sigmoiditis the patient flexes the left limb; the abdomen over the sigmoid is very sensitive to pressure, and the lower segment of the left rectus abdominis is in a state of contraction. These symptoms are but indicators that the inflammatory process, localized at first to the walls of the lower bowel, has spread by means of the lymphatics to the adjacent peritoneum. Such an extension would be very easy, for the sigmoid is without a mesentery, and is connected to the body wall by a loose meshed tissue. When peritonitis occurs all movements of the body, especially those producing stretching or traction of the abdominal wall, are very painful. These painful syndromes are present only in acute cases, the chronic ones being entirely or almost entirely free from pain.

Often in cases of mucous colitis considerable pain is present previous to the discharge of casts of the bowel or of large shreds of mucus. This pain is relieved as soon as the bowel discharge commences, but abdominal tenderness persists for some time. Colicky pains in the lower part of the abdomen, on the left side, followed by tenesmus and mucus-stained stools, are pathognomonic of sigmoiditis. Inflammation of the sigmoid is very rare without, at the same time, an associated inflammatory state of the rectum. The latter produces symptoms similar in some particulars to those of inflammation of the colon and sigmoid, but differing in many important details, because the lower position and the nearer relationship of the rectum to the spinal nerves cause the pain to be more that of a referred spinal type. The rectal pain-producing diseases will be considered in a later section.

Displacement of the Colon.—A rather poorly understood cause of pain in colonic disorders is displacement. That pain is caused by displacement of the colon cannot be doubted, though, at the same time, the opinion is widely held that displacements, even of a major degree, may be present without producing the slightest pain. The manner of the pain-production varies widely, depending upon the portion of the gut involved. Should the displacement occur on either the right or the left side, the pull is upon the lateral mesocolon, and to some extent upon the kidney, through the nephrocolic ligament. If the displacement on the left side is great enough, a pull upon the spleen also occurs through the splenocolic ligament. If the lesion is on the right side, traction is made upon the liver through the hepatocolic ligament. When any of these conditions occur, aching and distress are present in the regions associated with the organs secondarily involved. Should the transverse colon be affected, the pull is exerted upon the stomach and the organs closely connected with it, as the pancreas, liver, and gall-bladder, and indirectly upon the diaphragm, thus producing a symptom-complex involving all these organs. As they are all supplied by the solar plexus, a general aching and distress, sometimes amounting to actual pain, with an ill-defined localization in the lower abdomen, result.

As a sequela, associated with displacement, is distention. It occurs from the lodgment of fecal matter at one of the low places in the distended gut with a consequent obstruction and distention of the proximal segment of the bowel from gas. In some cases, owing to the weight of the fecal matter, the bowel sags and a kink results. The onward progress of the feces and gas is obstructed, and, as a consequence, dilatation of the bowel occurs on the side proximal to the obstruction. The signs and symptoms of distention (which are described under that heading) then appear.

In a brief résumé it may be stated that the localized pull upon the peritoneal attachments due to displacement produces signs referable directly to the organs involved, while the pull upon associated organs produces pain and symptoms referable to those organs.

The consideration of the causes of colonic displacements is beyond the scope of this work, but a brief review of the effects of change of position, etc., upon the production and character of the pain may be permissible.

If the displacement is of either the ascending or the descending colon, the position of the patient lying upon the side opposite to that in which the bowel is displaced will often cause considerable and lasting pain. The pain is of a dragging, aching character, and may continue until the patient turns upon the opposite (affected) side, and allows the displaced bowel to assume its natural position, and permit the gas and fecal matter to have an unobstructed passage.

Displacement also causes a tumor formation, which, as a rule, is tympanitic, and varies in size, depending upon change in the position of the patient. It can often be reduced by pressure, the reduction being accompanied by audible gurgling, and by a relief of the distress. An alteration of the diarrhea and constipation often occurs. When this symptom-complex is present it should at once attract our attention to the colon. For other signs, consult Distention (cf. p. 491).

Should the displacement be due to the drag of a tumor, palpation will reveal the abnormal formation, and, at the same time, the type of the displacement.

OBSTRUCTION.—Obstruction of the sigmoid by hardened feces is a common cause of pain. In this condition there also may be an alternate diarrhea and constipation.

NEW GROWTHS cause pain as a result either of displacement or of obstruction.

The Rectum.—Rectal pain is of two classes: (*a*) local and (*b*) referred.

Local pain is due to ulcers, new growths, strictures, etc. The pains produced by these lesions are more frequently the result of involvement of the neighboring structures than of direct irritation of the nerves ending in the walls of the rectum. In all these conditions there is, in addition to the local pain, a referred pain, which may be felt in the lower lumbar or sacral regions of the back, on one or on both sides. These regions are supplied by the fourth sacral nerve, which is distributed both to the rectum and to the skin over the sacrum. In some cases, owing to associated nerve involvement, the pain may be referred to the perineum, down the back part of the thigh, and even to the penis, or to the labia. The upper part of the rectum is without pain, and can be greatly distended without distress. Because of its non-sensibility it becomes the receptacle of the hardened feces.

Pain may be referred to the rectum from adjacent organs, as the uterus, tubes, ovaries, prostate, posterior urethra, or trigone of the bladder. In these conditions the pain has more of an aching character, and there is a constant desire to go to stool.

Nervous disorders also cause pain referred to the rectum. The following nervous disorders, it is said, cause rectal referred pain: epilepsy, locomotor ataxia, neuralgia, and hysteria. It is, however, a disputed question if any nervous derangement can, without some definite rectal pathology, cause local rectal pain.

The nerve supply of the rectum includes both sympathetic and cerebrospinal nerves. The sympathetic supply is derived chiefly from the inferior mesenteric and pelvic plexuses and from the nerves accompanying the superior and middle hemorrhoidal arteries.

The cerebrospinal nerve supply is derived from the second, third, and fourth sacral nerves, which enter the sacral plexus and are distributed to the rectum through the following nerves: (*a*) the inferior hemorrhoidal, which supplies both the rectum and the anus; (*b*) the superficial perineal, a branch of the pudic, which supplies the levator ani and the skin in front of the anus. The skin around the anus is supplied by the inferior hemorrhoidal branch of the pudic (Piersol). The pudic nerve is derived from the same segment of the cord as is the sciatic. Therefore, irritation of this nerve by ulcer or fissure of the lower rectum or anus may be referred as pain down the leg along the course of the sciatic.

The central origin of the nerve supply of both the rectum and anus is located about the level of the first lumbar vertebra. This is about the same level as that for the bladder and genitourinary systems. Thus we have the explanation of the close sympathetic bond existing between the two systems.

INFLAMMATION OF THE RECTUM.—Inflammation of the rectum, called proctitis, as a rule, is of little moment, unless it passes the catarrhal stage and becomes of a dysenteric type. Proctitis of the catarrhal type may give rise to no symptoms except a sense of distress in the rectum, and, in some instances, an aching referred to the back over the sacrum. Pathognomonic of catarrhal proctitis are griping pains in the lower abdomen, with constipation, and, in some cases, nausea and vomiting. In addition to these symptoms, there is at times the occasional passage of a small quantity of blood-stained mucus. Should constipation be pronounced, the stools hard and dry, and tenesmus and sacral pain marked, trophic proctitis is most likely. Rectal tenesmus is present in all varieties of proctitis.

In proctitis hemorrhoids are almost constantly present, and should not be mistaken for the disease; nor should pruritis, which often is severe, lead one astray in making the diagnosis.

Dysenteric proctitis is the most severe form of rectal inflammation. It causes the most pronounced aching in the pelvis and about the anus, and also produces "burning and heat in the lower part of the rectum, severe tenesmus, constant diarrhea, and rapid exhaustion."

NEW GROWTHS.—The new growths of the rectum causing pain are carcinoma and gummata. *Carcinoma* of the rectum, if it is above the mucocutaneous folds, is generally painless. One of the unfortunate things about this dread disease is that its onset is so insidious and symptomless that its cryptic advance is not suspected until it has progressed so far that treatment is of no avail. Yet, because of the morning diarrhea and the discharge of pus and blood, attention should be focused early upon the rectum as the seat of the trouble.

Gummata of the rectum are painless. At the anus they are inversely as frequent as are the primary lesions in the same location. The probable reason for the lack of pain in gummata of the rectum lies in the fact that they are seldom accompanied by inflammatory reactions, and pain, if it is present, is chiefly caused by distention, and, because of the laxity of the tissues at this place, is very hard to produce. Another reason for the absence of pain is that gummata rarely suppurate, and, therefore, the nerves are but seldom involved in an inflammatory process.

Ulceration.—The most common cause of rectal pain is ulceration, and I cannot do better than quote from Tuttle, who so thoroughly covers the subject. He says that in this condition "pain is a very sharp, unreliable, and indefinite symptom. Certain individuals suffer greatly from it, while others have no pain at all. If the ulceration is high up in the rectum, a sense of weight and aching in the sacral region is the chief discomfort of which most patients complain, while, if it is situated lower down within the grasp of the sphincter and involves the mucocutaneous fold, which is rich in sensory pain-receptors, pain of a sharp, lancinating, burning character will be the chief complaint. This pain is the result of contraction of the internal sphincter, which makes pressure upon the exposed sensory receptors. The amount of the pain varies considerably with the character of the ulceration. Tuberculous ulcers are almost entirely free from pain. Syphilitic ulcers vary considerably in the amount of pain which they produce. Sometimes they are very sensitive; at other times the patient is almost entirely free from pain. This freedom depends, to a considerable degree, upon the location of the ulcer. As a rule, ulceration of the rectum is not an acutely painful affection."

Varicose ulcers of the rectum, because of their location above the mucocutaneous fold, are a rather negligible quantity as a cause of acute pain. However, there is present a dull aching in the back, and sometimes shooting pains run down the leg or around the pelvis. Should the sphincter be involved, the pain, because of the excessive contraction of this muscle, becomes very acute. If the varicosities are large enough to be termed *hemorrhoids,* the pain is much more severe. It is especially marked should the hemorrhoid be of such a size that it can prolapse through the anus and be grasped by the sphincter. Hemorrhoids may cause pain referred over the sacrum, in the back, and down the limbs.

Ulceration accompanying Bright's disease usually is without pain.

Ischiorectal Abscess.—In ischiorectal abscess the infection is generally ushered in by a well-defined chill, and a feeling of discomfort which is soon followed by a throbbing pain. Examination reveals an induration around the anus; redness may or may not be present, depending upon the extent and severity of the infection. The patient generally has difficulty in urination, and defecation may be and usually is extremely painful. In some cases a hematoma may simulate an ischiorectal abscess, but on opening the swelling the only thing found is a collection of blood. As soon as this is evacuated the pain disappears.

Pain Due to Constipation.—Neuralgia is often associated with constipation. This is due in large part to direct pressure by the fecal mass upon a nerve or a nerve plexus. Continued pressure causes traumatism, and leads to a pressure neuritis. Lowered vitality of the nerve-stem, due to pressure, also permits infection. Thus, there may develop an infectious neuritis, as well as a pressure neuritis.

Constipation.—Colicky pains are produced by constipation, and are the result of the distention of the bowel by gas or fecal matter, or they may be the result of enterospasm, due to irritation from the stagnated feces, or their contained toxins. These pains are, as a rule, localized in the central part of the abdomen. The abdominal muscles are sometimes associated in the symptom-complex and are strongly contracted. Frequently the contraction of the muscle is confined to the portion which lies over the area of the involved bowel.

The Anus.—The lowest part of the rectum, the anus, is the part most subject to painful reactions. These are the result of two factors: (1) the great sensitiveness of the sensory receptors in this location, and (2) the presence of two powerful, constant acting sphincters, whose contraction produces severe pressure upon the exposed and irritated nerve filaments. Because of these conditions, the slightest ulcer in this area is provocative of the most extreme distress. The nerve stimuli from the anus areas are conveyed in the fifth sacral nerve, which also supplies the integument over the sides and the tip of the coccyx. This accounts for the referred pain felt over this area in anal disorders.

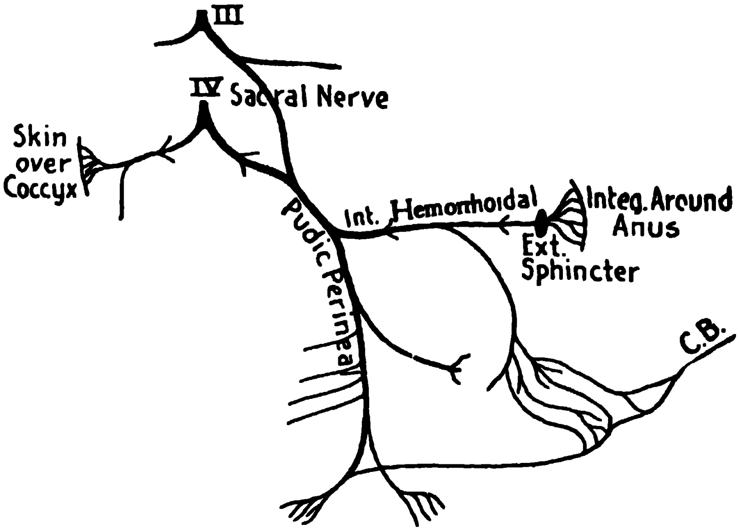


FIG. 106.—IRRITATION AT EXTERNAL SPHINCTER REFERRED TO SKIN OVER COCCYX.

ANAL FISSURE.—The most painful of the anal affections is a narrow and deep ulceration of the mucocutaneous junction, the so-called anal fissure.[1] The pain produced by this lesion is of two types, depending upon the stage of development. In the early stages the nerve endings are exposed on the ulcerated surface, and the pain is of a cutting, burning type, most marked after defecation. Later, as the sensitory fibers which have been exposed are destroyed, the pain is more dull and constant. During the course of the ulcer, owing to infection, and possibly traumatism of the adjacent nerves, a peri- and, in some cases, an interstitial neuritis may develop. There is then present a dull, throbbing ache, which radiates to the back and down the legs. This pain may persist even after the ulcer has cicatrized, because, even though the ulcer may heal perfectly, the neuritis will still remain.

[1] In anal fissure pressure upon the margin of the anus, just below the ulcer, is always painful. A large part of the distress may be prevented, should the patient lie down immediately after defecation. When the pain has persisted for some time it may be permanently relieved by forcible divulsion of the sphincter. The relief of pain by this means seems to be due, as described by Tuttle, to the release of the nerves from inflammatory adhesions with which they were surrounded, and to the removing of the pressure which had previously been exercised by the tightly constricting sphincter.

The description of the pain of anal fissure given by Tuttle worth quoting. He says, "The pain is very variable in time, nature, and duration. It may come on at stool, immediately thereafter, or half an hour or an hour after. It may be acute, cutting, tearing, as if a wound were being pulled asunder, or it may be a burning, hot, irritating feeling, accompanied with spasm and bearing-down sensation. Finally, it may have none of these characteristics, but assume a dull, heavy ache, with throbbing and distress similar to that of an aching tooth. The time during which the pain lasts is also as variable as its nature. Sometimes it lasts for only a few minutes, and the patient is then able to go about his business without any further disturbance till the next stool. At other times the pain and smarting are so severe that he is unable to move from his position at the toilet, or he must seek his bed, and lie there from one half to three-quarters of an hour until the acute agony has passed away. After this he is comparatively comfortable for the rest of the day. In others, the pain does not come on for some little time after the fecal movement, when smarting and burning are felt in the anal region. This sensation gradually changes to a throbbing, aching distress about the anus and the sacrum, which may last for several hours, or even, in some cases, all day long. Certain patients are never entirely free from discomfort. There is a pretty clear relationship between these pains and the character of the fissure.

"The acute pains, lasting only for a few moments, are ordinarily due to superficial fissures which involve the uppermost layers of the mucocutaneous tissues, healing partially from day to day, and recurring with each hard stool. They can be produced by forcibly stretching the anal folds apart. Such fissures are frequently associated with atrophic catarrh and late syphilis. The pains, which come on just after stool and last for one-half an hour or more, are ordinarily due to an ulceration between the radial folds of the rectum, especially in the posterior commissure. There is a slight red granulated base, thickening of the edges, with a sentinel pile, or two little teats at its lower end. The dull aching or throbbing pain, which comes on some time after stool, is generally due to a fissure or ulceration in the upper part of the anus, and involves the internal and the upper fibers of the external sphincter. It is ordinarily of long standing, deeper, and more indurated than the previous variety, but its edges are not so elevated and thickened, and it does not involve the skin at all, and can only be seen by the use of the speculum, or by forcibly stretching the anus apart. The late pains, occurring some time after a fecal movement, indicate that the ulceration is high up, while those occurring immediately thereafter would indicate a lower situation. In general, however, it may be said that the acuteness and severity of the pain are in direct proportion to the nearness of the ulcer to the anal margin. The more the mucocutaneous tissue is involved the greater is the pain. The reason of this is probably that the sensitive nerve fibers approach the mucous membrane from below, and are distributed in a gradually decreasing ratio as we ascend into the anal canal, disappearing almost entirely after the mucous membrane has been reached."[1]

The reflex pains associated with anal fissure are:

(1) Dysuria.—This generally occurs at the time of or shortly following defecation. This association is easily understood when it is considered that the anus and the lower urinary system receive their nerve supply from the same segment of the cord.

(2) Uterine and bearing-down pains (in women).

(3) Backache and neuralgic pains shooting down the leg.

(4) Facial and occipital neuralgic pains.

The neuralgia may be but an indication of the reaction of the nerves to the toxins which are circulating throughout the system, because, in anal fissure, the bowels, on account of the pain, are inactive, and the fecal matter accumulates, giving rise to a toxemia.

Perianal Abscesses.—Some perianal disorders are extremely painful. Of these abscesses are the most painful. Should an abscess be present in the subcutaneous tissue around the anus, and no pain be felt, it is a fairly good indication that the condition is due to tuberculosis. In such affections there is very little inflammatory reaction, and swelling and redness are absent. The discharge, thin and watery, passes out of a small opening which leads from a boggy central mass. All cases of fistula, abscess, and ulcer around the rectum, which have developed insidiously *without* pain, are generally tuberculous. Should the abscess not be tuberculous, but the result of an infection from a pyogenic organism, there is at first a preliminary feeling of discomfort, quickly followed by sharp and severe pain. Examination will, in this case, disclose a small, round, inflammatory area, which is hot and red, and exquisitely tender to the touch. The patient also has fever and an increase in the pulse rate.

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[1] "Diseases of the Anus and Pelvic Colon," p. 300.

CHAPTER XXV

THE APPENDIX

The appendix is located in the right iliac region at a point about two inches from the umbilicus on a line running from the umbilicus to the anterior superior spine of the ilium. It generally lies deep in the abdominal cavity, and has no direct connection with the abdominal wall. As a rule, it and the adjacent loops of the bowels are covered by the omentum, which hangs over and protects them from injury, either traumatic or infective.

It is, in the majority of cases, free, although its excursions and movements are somewhat restricted by a short mesentery which joins the right leaf of the mesentery proper and is called the mesoappendix. Through this mesoappendix the appendix derives its blood and nerve supply. The blood supply is derived most frequently from the posterior branch of the ileocecal artery, formed from the junction of a branch from the iliocolic with one from the colica dextra. The nerve impulses are carried through the superior splanchnic of the sympathetic.

The researches of Neumann (127b) have definitely shown that the splanchnics convey painful sensations to adequate (tension) stimuli.

The pain[1] in appendicitis is, in the early stages of the attack, found to be general, or, as it is termed, diffuse, being distributed over the entire abdomen, though frequently it is first perceived in the epigastric or umbilical region. Then it becomes localized to the region of the appendix and, as the peritoneum becomes involved, it again spreads. In gangrenous appendicitis there often is lack of pain, assumed to be due either to benumbing of the pain receptors by the toxemia, or possibly because there are no peristaltic waves set up in the appendix. The diffuse pain is probably due to an explosion of nervous impulses, which are produced in the appendix by the sudden distention and consequent traction thus induced upon the mesoappendix.[1] It has been stated by Lennander [2] that all pain arising from intraabdominal changes is due to peritoneal traction produced by these changes. The secondary pain, which becomes localized to the region of the appendix, may be due

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[1] The nervous system of woman reacts to pain more readily than does that of man (265, p. 408).

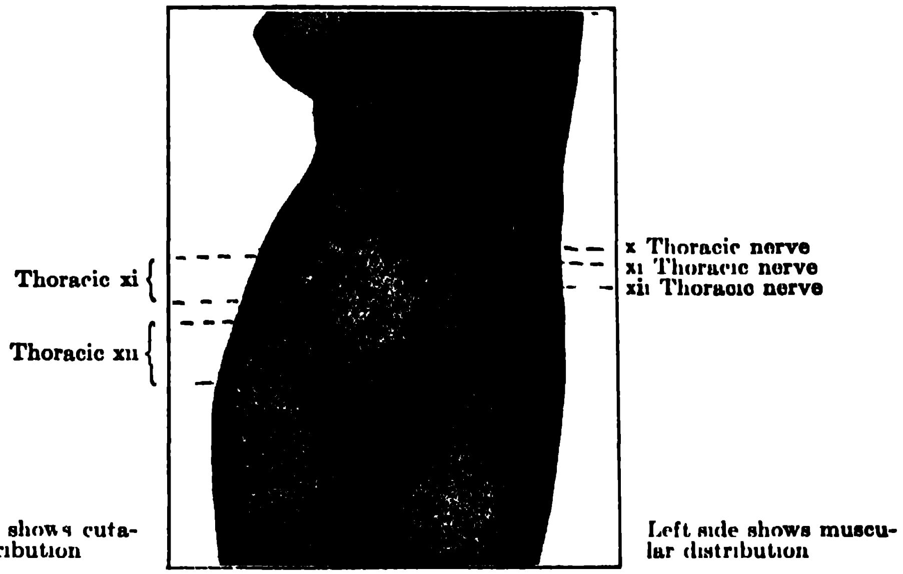
Thoracic xi
Thoracic xii
Right side shows cutaneous distribution
x Thoracic nerve
xi Thoracic nerve
xii Thoracic nerve
Left side shows muscular distribution

Fig. 107.—Cutaneous and Muscular Distribution of 11th and 12th Thoracic Nerves.

It is seen that the eleventh thoracic supplies principally the lower segment of the rectus abdominis muscle. Thus since this segment is the one usually connected with the appendix it is easy to understand the reason for the local and segmental contraction of the rectus muscle in appendiceal inflammatory states.

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[1] Moullin (226, p. 515) claims that the initial pain of appendicitis is due to the "peristaltic action of the cecum or of the appendix dragging upon the attachment of the cecum to the abdominal wall." When the inflammation spreads to the muscular coat the latter can no longer contract, and as a consequence the pain ceases. Moullin also claims that such a relationship is shown by the fact that the cessation of the umbilical pain is coincident with the formation of a local swelling "due to distention of the bowel and the thickening of its walls by inflammatory exudate."

[2] Lennander's explanations, however, as has been repeatedly pointed out, are not valid, because of the oversight of what constitutes an adequate stimulus for the internal viscera.

to involvement of the terminal sensory filaments of the spinal nerves distributed to the appendix.[1] These refer the sensation to their terminal somatic filaments and the abdominal wall and, since the eleventh spinal segment (Deaver) is connected with the appendix, the pain will be referred to the filaments of distribution of this segment. The principal points of emergence of these nerves are near McBurney's point, thus accounting for the pain in this neighborhood.

It is also possible for an appendix to be inflamed and give rise to no symptoms. For example, in many cases I have examined appendices where strictures were present, indicating an old inflammatory reaction, and yet the patient was unable to recall any attacks of pain resembling an appendicitis.

Varieties of Appendiceal Pain.—Pain in appendicitis may be divided into the following classes:

I. Local pain due to:
  (1) (*a*) Obstruction.
      (*b*) Inflammatory swelling.
  (2) Inflammation:
      (*a*) Mural.
      (*b*) Extramural.
  (3) Adhesions:
      (*a*) To other abdominal viscera.
      (*b*) To the peritoneum.
II. Distant pain, which may be:
  (1) Referred pain:
      (*a*) To the abdominal wall of the same side.
      (*b*) To the tunica vaginalis testis and also to the sacroiliac region.
  (2) Transferred pain:
      (*a*) To the abdominal wall of the same side, at a higher or lower level.
      (*b*) Crossed to the abdominal wall of the other side, at the same or at a higher or lower level.

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[1] It is questionable whether the terminal filaments of any spinal nerve ever really reach the appendix.

(3) **Reflex:**
  - (*a*) **Headaches.**
  - (*b*) **Reflected pain.**

Local Pains.—(1) *Obstruction.*—The local pains are due to: appendiceal colic, the result of obstruction of the lumen of the appendix by (*a*) some indigestible food, (*b*) a foreign body, (*c*) a kink in the appendix, or (*d*) constriction by adhesions.

(*a*) In some cases indigestible food, as the chaff of the wheat grain, or of any other cereal, or the seeds of various fruits and berries lodge in the appendix, and, because of diminished muscular power, it is unable to extrude them; consequently, they remain in its lumen and are a source of irritation. This irritation is the signal for the gathering of germs which produce a mild grade of inflammation; and, as a consequence of it, fermentation and a slight dilatation of the lumen occur; this in turn stimulates contraction, and this causes the pain. (*b*) Foreign bodies may lodge in the appendix, as fecal concretions, or seeds. (*c*) Kinks may occur in the appendix. In these conditions the bend in the appendix hinders the emptying of its lumen; consequently, there is an accumulation of secretion and fecal material on the side distal to the obstruction. This causes distention, with a consequent tendency of the appendix to straighten out, and there results a great pull and drag upon the segment of the mesoappendix to which the distended segment is attached. This either initiates a pain or adds to the pain which is already present. If the obstruction is near the end of the appendix, and the appendix is unable to contract, there is little, if any, pain from the obstruction. (*d*) The active causative factors of pain due to constriction by adhesions are the same as when kinks are present.

Obstruction may be due to an inflammatory swelling, which causes a blocking of the lumen of the appendix, distal to which the distention occurs, with consequent pain production.

(2) *Inflammation.*—The pain of appendiceal colic is, in many instances, due to an associated inflammation of the ileum, because of which the peristaltic waves become painful. This adjacent in-

flammation is more definitely indicated by the close association of these attacks and the subsequent diarrheas.

Inflammation of the appendix may be divided into three stages:

(*a*) Inflammation which is confined to the mucous and the submucous coat. Often, in this condition, no actual pain is present; rather there is a sense of discomfort, which, as a rule, is referred to the region of the umbilicus. This is the class of cases in which the complaints are mainly digestive, such as presence of gas in the stomach and intestines, distress after eating, and a tendency at times to nausea and vomiting. These symptoms are but the reflex indications of a sympathetic involvement. Should the onset of the inflammation be sudden, the shock to the sympathetic system is greater, the above symptoms are increased, and a well marked, referred pain is present.

(*b*) Inflammation of the muscular coat follows closely upon that of the mucous. To the above symptoms, well-defined local pains are now added. These, following closely upon signs of mucosal involvement, are a sure indication that inflammation is spreading.

(*c*) Involvement of the peritoneal coat nearly always occurs if the inflammation is severe. This happens, as a rule, only in acute processes; that the peritoneal coat may be involved in a chronic inflammation is possible; but by far the vast majority of peritoneal inflammations arise from an acute inflammation. If the attack is acute and the inflammation has advanced to the peritoneum, there is then present a greater intensity of the cutaneous hyperalgesia and referred pain. Following the onset of the local pain, also, in some cases, in which the appendix is so situated that it lies in close contact with the parietal peritoneum, this layer also becomes involved in the inflammatory process. The local peritonitis is then manifested by exquisite local tenderness. With peritoneal involvement the sympathetic reflex symptoms are increased; nausea and vomiting occur, local peristalsis ceases, constipation ensues, distention of the bowel comes on, and symptoms of toxemia appear. These are accompanied by an elevation of temperature and a rise of the pulse and respiratory rate. Another sign of importance (reflex in nature) is the cessation of diaphragmatic breathing as soon as the peritoneum becomes involved. It is of importance, in deciding the extent of involvement, to note the presence or absence of irritative peristalsis in the cecum. The manner of obtaining this is suddenly and lightly to palpate over the appendiceal region, having, at the same time, the bowl of the stethoscope over the cecal region; should the peritoneum be involved, no peristalsis will take place; should the peritoneum not be involved, peristalsis will immediately follow. This sign has been elicited in many cases.

(3) *Adhesions.*—Should adhesions from the appendix drag upon the parietal peritoneum, the pain is sharply localized to the area of adhesion, is of a dragging nature, and is worse when certain positions are assumed by the patient. A right lateral recumbent posture often seems to be conducive to the induction of this pain. Active movements, also, as bending forward or backward, will cause pain, if the appendix is adherent to the anterior abdominal wall. Bowel distention, by dragging upon the adhering peritoneum, will cause pain, which ceases upon the passage of the bowel contents. Adhesions between the appendix and the body of the psoas muscle are often the cause of the pain felt by those suffering from chronic appendicitis when they attempt to climb stairs.

DISTANT PAINS.—Pain in appendicitis is sometimes felt at a distance from the site of the appendix. These pains are due to stimuli transmitted from the site of the original lesion through the nervous system to nerve collaterals. This stimulation is perceived as pain, and is felt as coming from the area of distribution of the nerves originating in the centers irritated.

The distant pains may be classed as referred, transferred, and reflected.

REFERRED PAIN.—Referred pain is due to the transmission of the stimuli along the splanchnics to the related spinal centers in the cord, and the pain seems to be produced in the area of distribution of the latter. By a study of the figures following, the location of the transferred pains may be seen. It is also shown how irritation to any division of the eleventh nerve will cause a contraction of the rectus, particularly the segment supplied by the eleventh thoracic nerve. Should the irritation be strong enough, the tenth nerve may also be irritated, and segments of the muscle above the part supplied by the eleventh may also be thrown into contraction. The figures also show how dorsal cutaneous tenderness and lumbar pain may be present, the areas in which they are found being marked off on the figure. Pain is, in some cases, also referred to the vaginalis testis of the same side, or it may be referred to the extreme lower part of the abdomen, or to the upper part of the thigh.

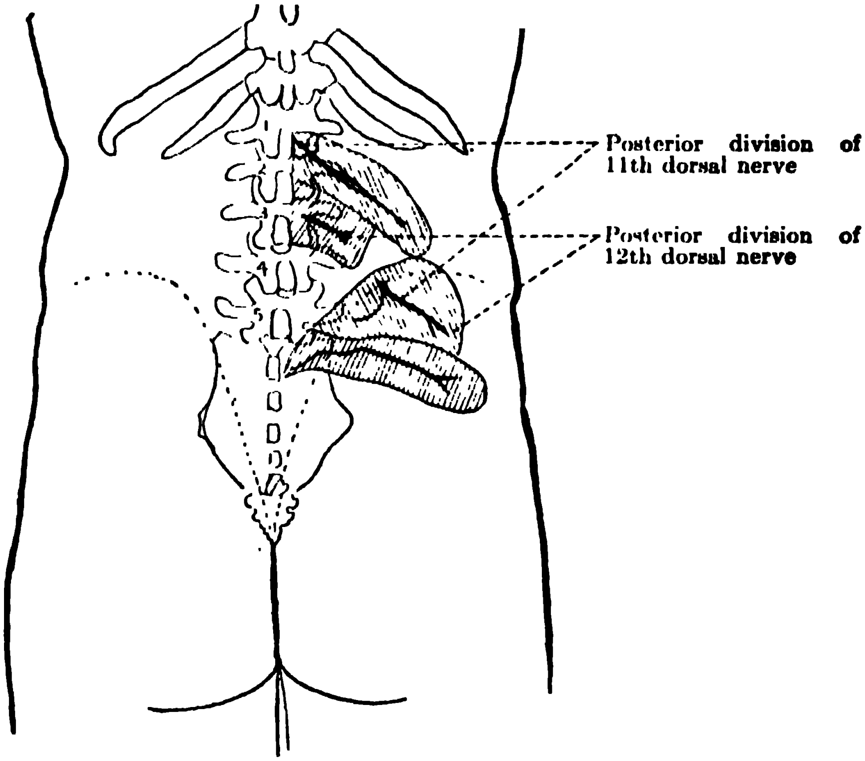
Posterior division of 11th dorsal nerve
Posterior division of 12th dorsal nerve

FIG. 108.—AREAS SUPPLIED BY THE POSTERIOR BRANCHES OF 11TH AND 12TH THORACIC NERVES.
The figure illustrates how appendiceal pain may be felt posteriorly in the distribution areas of these nerves. (Drawing modified from Toldt.)

This reference is through the first lumbar nerve, which is distributed to the lower abdomen and upper part of the thigh; also, through a small branch to the tunica vaginalis testis.

TRANSFERRED PAIN.—By transferred pain is meant that form of pain which is felt on the opposite side or at a higher or lower level of the body than the lesion causing it. It is due to the transmission, upward or downward in the cord of the stimulus from the point of origin.

In the following drawing, modified from Toldt, it may be seen how an appendiceal pain may be transferred across the cord and be felt on the opposite side, the arrows indicating the origin of the stimulus in the appendix, its conduction to the thoracic sympathetic ganglion, and thence its transference either to the anterior or to the posterior division of the nerve, the pain being felt

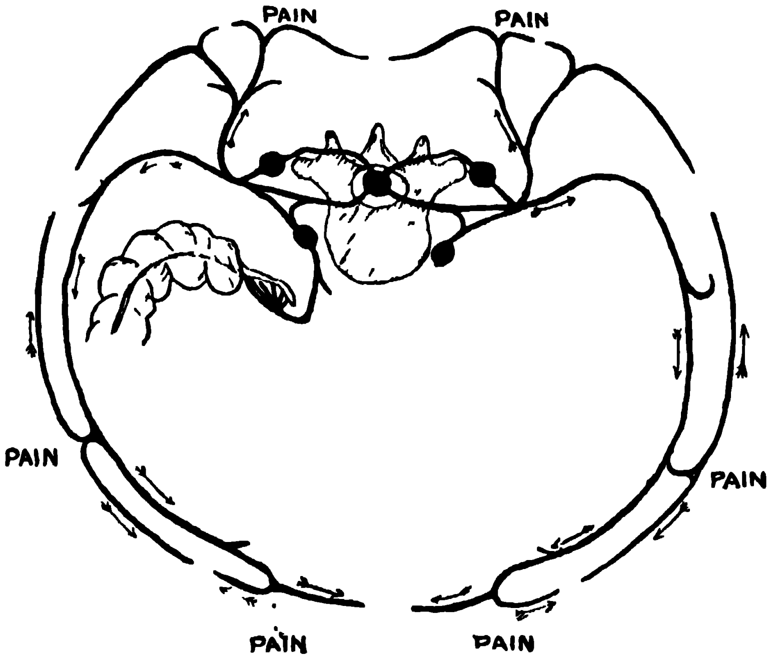

Fig. 109.—Areas of Pain Referred from the Appendix. The arrows indicate the direction of the referred sensation. The two sets of nerves are the superficial and the deep nerves of the abdominal wall At the point where they pass through the wall and become superficial pain is felt. (Drawing modified from Toldt.)

either in the anterior or posterior abdominal wall. At its beginning the anterior division of the nerve lies in close relationship with the peritoneum, so that any irritation of the peritoneum would cause pain, which would be felt either at the point of production, or would be referred to the anterior abdominal wall. Irritation at this point would also stimulate the motor fibers in the nerve and segmental contraction of the rectus would result.

Reflected Pain.—The sympathetic nerve supply to the appendix is derived from the superior mesenteric plexus, which receives its supply from the ninth, tenth, eleventh, and possibly the twelfth dorsal segments. It seems, however, that the origin is chiefly from the eleventh and twelfth dorsal segments, the eleventh being the one most often involved in appendiceal lesions. In case of very sudden onset, with severe toxemia, reflected pain may be absent. It is also frequently absent in secondary attacks, because of the destruction of the nerve endings, which has occurred in the primary attack. In these cases of reflected pain the pain is due either to inflammation or to distention of the appendix. That the inflammation alone can cause it is well authenticated; while the fact that the reflected pain may suddenly cease on perforation of the appendix demonstrates that it also is caused by appendiceal distention. Figs. 112, 113, and 114 represent a complete drawing of many of the reflected pains felt in appendicitis.

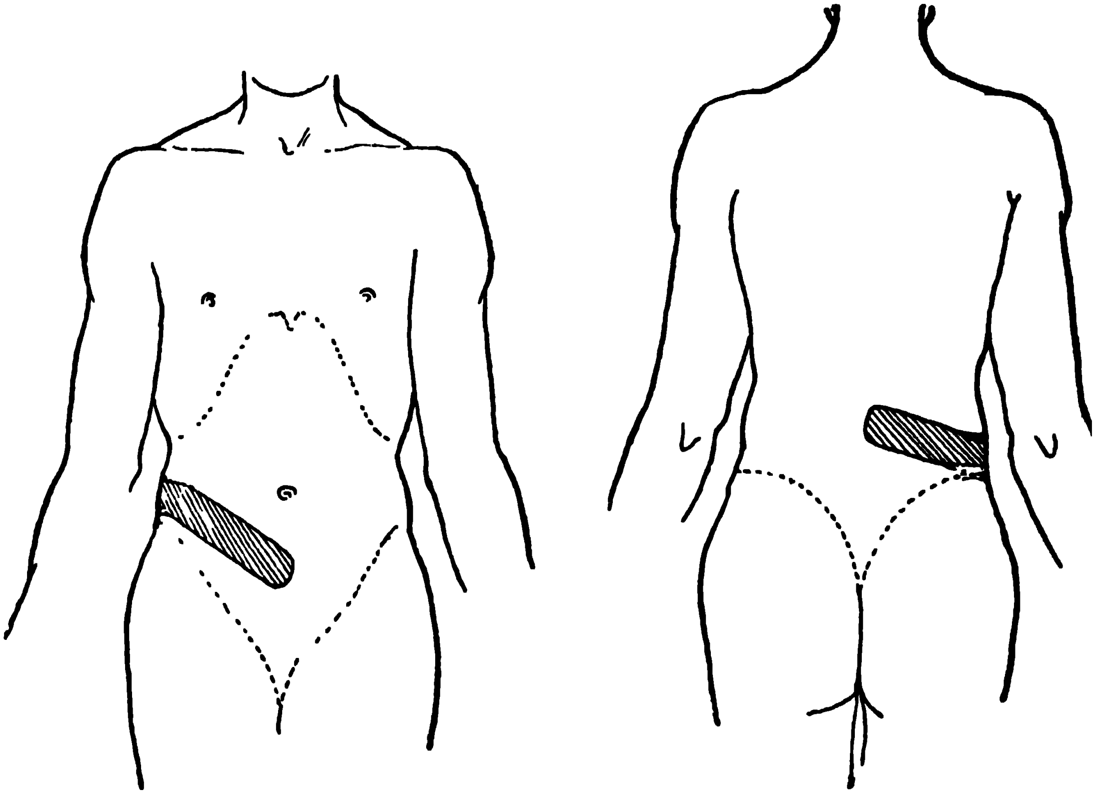

Fig. 110 Fig. 111

Figs. 110 and 111. Areas of Cutaneous Hyperalgesia in Appendicitis Corresponding to the 11th Dorsal Area of Head.

Reflected cutaneous hyperalgesia is difficult, if not impossible, to elicit, should ice or counter irritation have been applied to

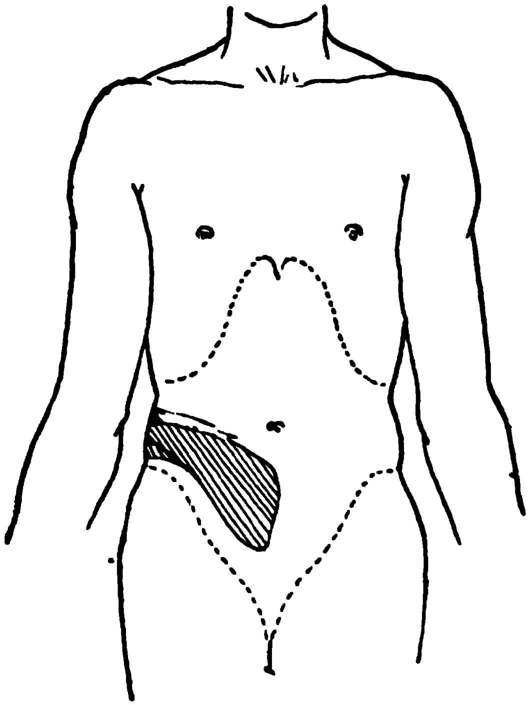

Fig. 112.—Reflected Pain in Appendicitis. Triangle of cutaneous tenderness. (Drawing from Sherren, 92.)

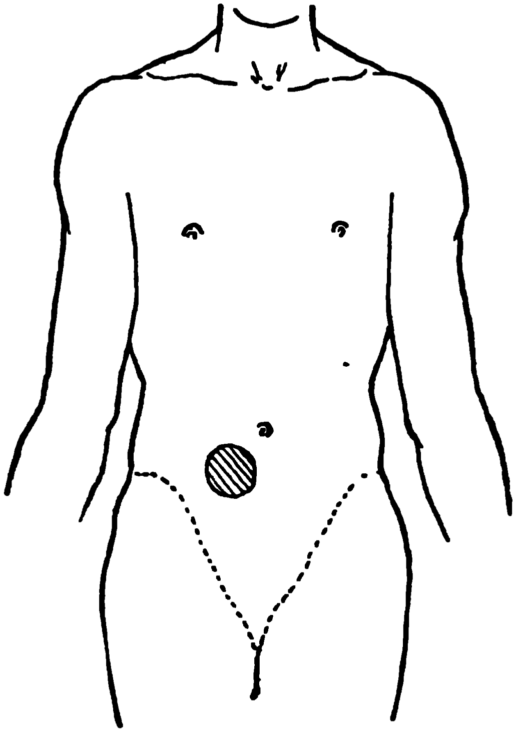

Fig. 113.—Reflected Pain in Appendicitis. Small circular area of cutaneous tenderness occasionally present. (Drawing from Sherren, 92.)

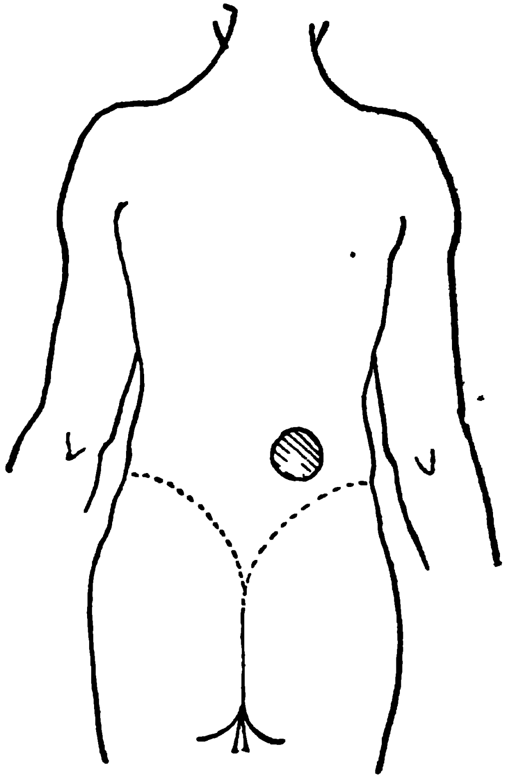

Fig. 114.—Reflected Pain in Appendicitis. Rounded patch of cutaneous tenderness in lumbar region. (Drawing from Sherren, 92.)

the patient a short time previously, because both reduce the cutaneous sensibility.

According to Maunsell Moullin (226, p. 516), "When hyperesthesia is definitely associated with other evidence pointing to an inflammation of the appendix, it may be taken as a clear indication that the wall of the appendix itself is involved and that, therefore, though the inflammation may subside, it will in all probability leave some permanent alteration in the ap-

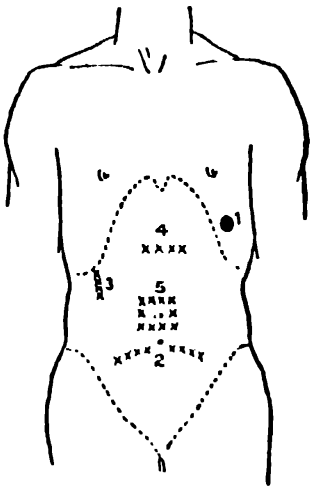

Fig. 115.—Location and Radiation of Sympathetic Reflected Pain in Appendicitis.

1. Probably indicates some traction on the splenocolic ligament from pull on the colon.
2. Appendix is probably directed to left side, mesentery being derived from left.
3. Appendix being directed up under the colon.
4. Referred pain in early stages of appendicitis.
5. Referred pain in early stages of appendicitis.

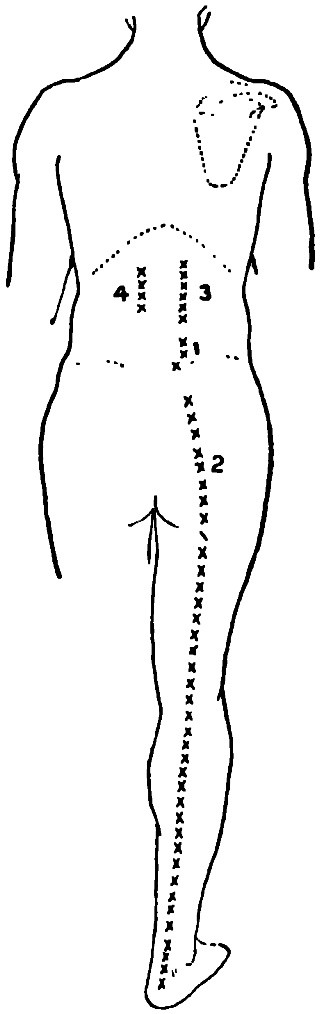

Fig. 116.—Location and Radiation of Sympathetic Reflected Pain.

1. Pain in this case was referred to the sacroiliac synchondrosis.
2. Pain was present over the sacrosciatic notch and radiated down the leg. Appendix was found lying across the psoas muscle, being entirely retroperitoneal. No mesoappendix was present except about ½ inch at extreme tip of the appendix.
3. Same as 3 in Fig. 115.
4. Pain over left kidney due to gangrenous appendix, no kidney lesion.

pendix, which later will necessitate operation. Sudden cessation of the hyperesthesia without at the same time any improvement in the other symptoms often indicates that the appendix has become gangrenous."

Figures 115, 116 and 117 show the location and radiation of sympathetic reflected pain.

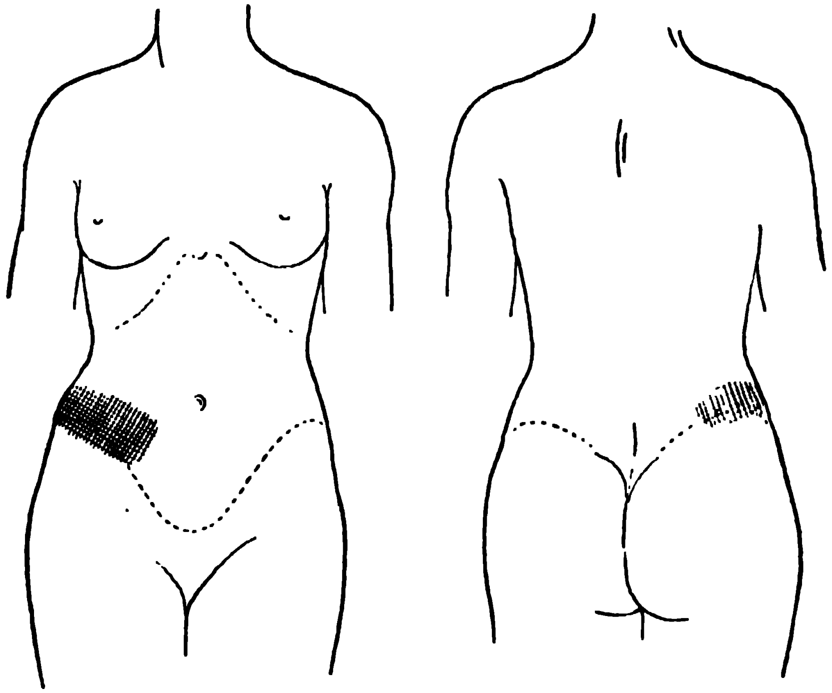

FIG. 117.—AREAS OF HYPERALGESIA IN THE 11TH DORSAL VISCERAL SEGMENT DUE TO APPENDICITIS OF THE CATARRHAL TYPE.

The pain of appendicitis is well illustrated in the accompanying case, in which the acute pain, present in the right side, was associated with a well-marked hyperalgesia over the same area. As the subjective pain decreased, the hyperalgesia also decreased, so that when the subjective pain was gone the latter also was entirely absent. Deep pressure over the appendix area still caused pain, but no hyperalgesia, so that the patient was tender but not hyperalgesic. This illustrates the independence of the two symptoms. On operation the appendix was found enlarged, swollen, and very much inflamed. It extended along the right side of the abdomen, running up in the direction of the liver. Adhesions were not present.

The following photographs are of a boy eight years of age,

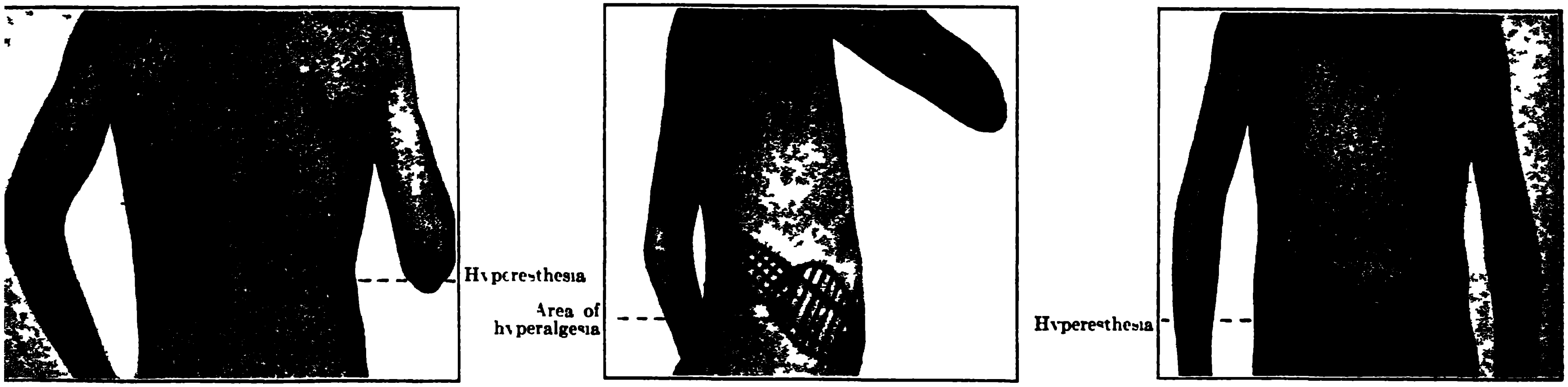

FIG 118 —AREAS OF INCREASED SENSITIVENESS TO PAIN AND TO TOUCH IN APPENDICITIS

The area with the squares indicates hyperesthesia of the 11th dorsal zone the shaded area hyperalgesia and the circle around the umbilicus the area to which the patient refers his pain The black dots indicate the points of maximum tenderness, the one near the umbilicus the maximum point of tenderness of the 11th dorsal segment, and the one on the iliac crest the maximum point of tenderness of the 12th dorsal segment who complained of severe pain in the abdomen. Examination showed the following area of tenderness (see Fig. 118): the shaded portion, which indicates the area of sensitiveness to pain, such as to pinching; the cross-shaded portion, which indicates the area of sensitiveness to touch, and the dark spots, which indicate points of maximal tenderness (to touch), which were produced by deep pressure. The circle around the umbilicus indicates the region to which he referred his pain.

At first there was thought to be a possibility of malingering in this case, as on a second examination the area of sensitiveness had moved slightly, and on a third examination the area of cutaneous hyperalgesia was much smaller than on the first examination, being about one-half inch smaller at all points. This idea was dismissed later, as it was observed in several cases that the area of hyperalgesia may change according to the change in the position of the patient, and definitely according to that change; also that it becomes smaller as the disease progresses toward a cure.

Pain on the left side in appendicitis may, in some cases, be due to the position of the appendix on that side. Below are a few of the positions which the appendix may take, owing to a faulty rotation (*Annals Surg.*, July, 1908, p. 137).

Left-sided pain may also be due, in some cases, to an inflamed appendix situated in the pelvis on the left side.

Sympathetic pain, such as headache or generalized aching, so common in appendicitis, is the result of the action of the toxins (produced in appendicitis) on the centers supplying the areas in which the pain is present.

In connection with aberrant pains in appendiceal inflammatory states, it is a fact that, in many of these so-called pains, there is a separate anatomical basis for the pain-sensation. Appendicitis and colitis, says Lockwood (127b), are often closely related, and in those cases which had pain over various parts of the colon there was also associated a mucous colitis, which was the underlying cause of this most prominent and distressing symptom.

In regard to involvement of the colon in appendicitis and its relationship to pain-production, the reader is referred to the sec-

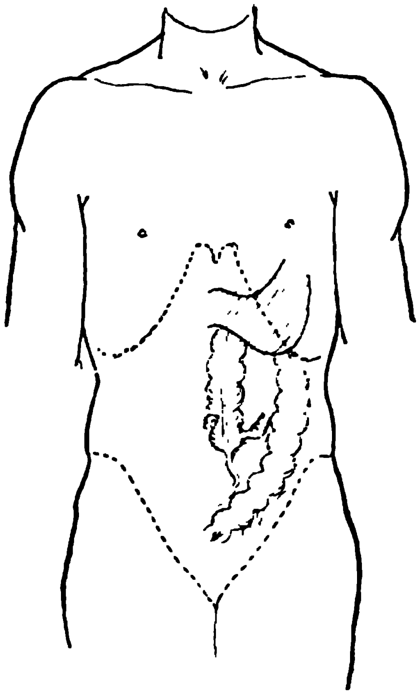

Fig. 119.

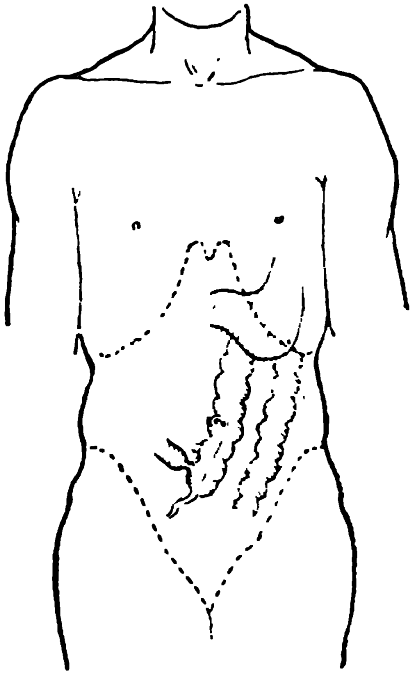

Fig 120.

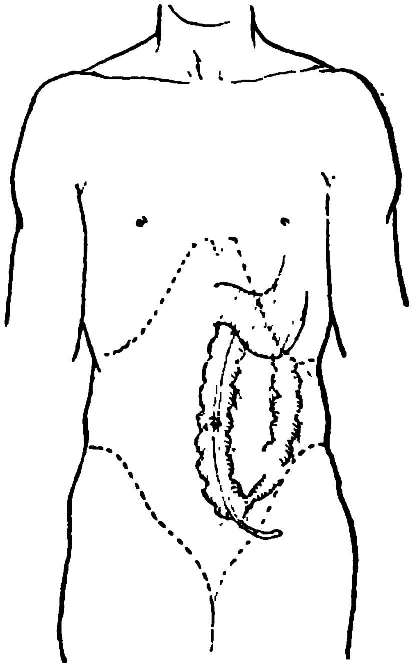

Fig. 121.

Figs. 119, 120, and 121.—Pain in the Left Side in Appendicitis.

Figures show the **positions** which the appendix may assume because of a faulty migration, and how **from local conditions,** peritoneal irritation, etc., pain may be felt on the left side.

tion on diseases of the colon, where the pain resulting from colonic involvement is carefully reviewed.

In this connection it is well, also, to recall the fact that epigastric pain, occurring at some late stage of appendicitis, or during the course of the disease after the pain has been localized in the right iliac fossa, is almost pathognomonic of a peritonitis (W. D. Stanton).

Tenderness in Appendicitis.—The following are Robinson's (265, pp. 414-415) conclusions in regard to the presence of superficial tenderness in disease of the appendix:

"In disease of the vermiform appendix, or in disease originating therein, cutaneous tenderness is sometimes present, most commonly in the skin innervated from the eleventh dorsal segment of the spinal cord, but also sometimes in the territory of the ninth, tenth, and twelfth dorsal, and possibly the eighth dorsal and first lumbar segments.

"According to Sherren (266), there are three chief forms of cutaneous tenderness. The first is in the form of a broad band, extending from about the level of the first lumbar vertebra around the anterior surface of the body, having a general downward direction, and ending below the umbilicus. Its lower edge rides over the crest of the ilium. The entire band closely corresponds to the area of sensory distribution of the eleventh dorsal segment. The second area is triangular, its upper boundary being on a level with the umbilicus, its apex over the crest of the ilium, and its base on the right side, toward the median line of the body. The third area is found about the middle of a line joining the umbilicus and the anterior superior spine. A corresponding area is on the back just above the iliac crest.

"A patient displaying an area of superficial tenderness of one of these three defined varieties is, in the great majority of cases, suffering from appendicitis. Nevertheless, many other diseases may resemble appendicitis in this respect; for instance, renal colic, perforated gastric ulcer, intestinal colic and perimetritis.

"Inflammation of nerve trunks is not the cause of this symptom, for the latter may occur in skin supplied by the post-primary divisions of the spinal nerves. There is little evidence as to the immediate cause of this reflex tenderness, but it is probably due to irritation of the afferent nerves from the appendix. The irritant is possibly, in some cases, tension; in others, it is almost certainly something different. The symptom is found in a minority only of the cases of appendicitis seen in hospital practice. It may, while a case is under observation, vary in character or disappear altogether. During the progress of an attack, it may appear in a patient in whom it has not originally been present.

"Cutaneous tenderness is found as frequently in subsequent as in first attacks of appendicitis. It may persist long after all other signs of the disease have disappeared.

"The prognostic and therapeutic significance of cutaneous tenderness, in cases of appendicitis, is slight. It is somewhat less often found in cases of abscess than in other cases. When the symptom and abscess coexist, the abscess is usually only a beginning process.

"Cases of widespread peritonitis, set up by appendicitis, may display large areas of cutaneous tenderness over the right side, or over the whole of the abdomen."

Tenderness as a Symptom in Appendicitis.—In two hundred and forty-seven cases, reported by Sherren (267), and Robinson (265), hyperalgesia was found in 66, or 26.7 per cent.: sixteen times as a complete band; thirty-two times as a triangle; fourteen times as a circular spot; and three times as a large, irregular area.

Sherren makes the statement that tenderness may be absent in attacks after the first, if the first attack was of sufficient severity to destroy nerve tissue in the wall of the appendix (265, p. 398). The number of cases examined by Robinson was one hundred and twenty-three, and the proportion of positive and negative cases was 21.1 and 78.9; but, as Robinson says, this does not invalidate Sherren's statement, for the occurrence of previous attacks may dispose the sufferer to superficial tenderness, and so made up for the cases in which nerve tissue has been destroyed. He further says that the cases he has seen are the severe and neglected ones; and that in the milder cases, which are seen in private practice, the presence of pain is more common.

During its disappearance, as the other symptoms of the disease clear up, the areas of hyperesthesia assume many irregular and migratory shapes.

Another conclusion of Sherren's is that the disappearance of cutaneous hyperalgesia, without improvement in the general condition of the patient, is a sign of perforation or gangrene, and should be the sign for immediate operation. Bennett (142, p. 1005) questions the entire accuracy of this statement.

According to Sherren, also (265, p. 399), the presence of cutaneous tenderness is no contraindication for operation. Abscess may form and general peritonitis develop while it is present. Of twenty-six positive cases, Robinson found abscess in eleven; gangrene in nine; perforation in seven; and general peritonitis in three.

"However, absence of cutaneous hyperalgesia is of great importance. Absence of cutaneous hyperalgesia in a patient coming under observation early in the first attack of appendicitis is a sign of gangrene of the appendix, unless the case is obviously mild and is getting well rapidly. (Robinson is in accord with this statement.) Cutaneous tenderness, as a rule, is absent in cases of abscess of the appendix. (This is true in two out of three cases.) The age of the patient and the position of the appendix have no influence on the cutaneous hyperalgesia. Cutaneous hyperalgesia is occasionally of use in the diagnosis of appendicitis. Cutaneous hyperalgesia, in the area which is associated with appendiceal disease, generally is an indication of appendiceal involvement, though of necessity it is not a pathognomonic sign, for it has also been noted in other conditions, such as perforated duodenal ulcer, intestinal colic, and peritonitis. In a case of perimetritis the area of hyperalgesia was in the form of the small circular patch, already described. This may be the same as Morris's point or area of tenderness" (Sherren, 265).

Varieties of Tenderness.—In acute appendicitis two varieties of tenderness are present: (1) *tenderness to superficial irritation* in which over certain areas light pressure, as the drawing of the point of a pin over the surface, produces pain. These areas of tenderness are but reflexes from the viscera, and correspond to the zones Head has worked out for the eleventh and twelfth dorsal segments. Recently Elsberg, of New York, has confirmed to a large extent the earlier observations of Head. The points of most exquisite tenderness are but the maximal tender points of Head.

Robinson says (265, p. 392) that it is "remarkable, in all definite cases of appendicitis, how definite is the line of tenderness between the tender and non-tender areas."

This superficial tenderness generally occurs during the first attack, which may be a very mild one. In some cases the discomfort may be the result of a mild inflammation of the mucosa, while in others for the pain production it is necessary that the peritoneum be involved.

Sherren (267, 625, p. 390) thinks that a superficial tenderness is due to stimulation of nerves within the appendix, the result of intraluminary tension. This statement is disputed by Robinson, who says that "inflammation and the products of inflammation are capable of acting just as well." He says further, that "tension may exist without tenderness, tenderness may be present without tension, and the mere destruction of the afferent nerve fibers or endings does not seem to abolish the symptom in all cases, any more than tension on them of necessity produces it."

(2) *Tenderness on deep pressure* is always an indication that the inflammation has spread to the peritoneum. It is generally, also, an indication of an abscess formation, in which the parietal peritoneum takes part. Should the peritoneal involvement be considerable, subjective pain will also be associated with the tenderness, and the muscles over the painful area will be contracted. This contraction is due to the beneficent reflex of Hilton, in which the muscles over an (inflamed) area supplied by the same nerve or nerves contract.

In chronic appendicitis the tenderness is due chiefly to the adhesions which are present. In this condition palpation of certain areas seems to be particularly painful. The increased pain is due to the much greater pull or drag upon the band of adhesions, resulting from the palpation. Peristalsis of the bowel will also cause pain. In examining patients for cutaneous tenderness see that no poultices, compresses, fomentations, or ice have previously been used.

Tenderness may also be found:

(*a*) In the lumbar regions when the appendix is retrocecal. Here the tenderness is probably due to direct pressure exerted by the cecum upon the appendix.

(*b*) Vaginal palpation may produce pain if the appendix lies in the pelvic cavity. It is very hard in this condition to distinguish by palpation an appendix from an inflamed fallopian tube. However, the other signs and symptoms present in appendicitis aid in the diagnosis. Should the appendix be in the pelvis, defecation and micturition, due to the traction exerted upon the appendix by the adhesions which bind it to the bladder or to the rectum, may be painful. Pain may also be present on bending and straightening of the thigh. When this is the case, the appendix lies on and is adherent to the psoas muscle, and the pain is due to pressure and traction, the result of movement and contraction of this muscle.

(*c*) Transabdominal tenderness.- In many cases a typical appendiceal pain can be produced in the area of appendiceal reflection by making pressure over the colon at the corresponding point on the left side. This area corresponds rather closely with Morris's point of tenderness in tubal and ovarian disease. Rovsing (Ref. 190) makes no mention, however, of the presence of tubal or ovarian disease, but states that in more than one hundred cases it was never found unless there was some affection of the cecum or appendix.[1]

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[1] Dieulafoy had first indicated the contraction of the abdominal muscles as an indicator of intraabdominal inflammatory states—the so called *muscular defense*, defense musculaire. This symptom is a good indication that gangrene or perforation, with beginning free or circumscribed peritonitis, has already taken place.

Special Points of Tenderness.—The presence of pain at McBurney's point has long been regarded as symptomatic of appendiceal involvement. This point is situated one and one-half inches from the anterior superior spine, on a line running from the anterior superior spine to the umbilicus. Pressure at this spot has been held to be productive of pain in diseases of the appendix. This area of pain is not constant, but it may be said that in general its presence indicates appendiceal involvement, while its absence is of no significance. In no case is its presence in any way connected with the location of the appendix. In fact, Lanz has shown that, as a rule, the appendix is some distance away from the painful spot, and generally is below it.

Morris, of New York, has described a point of tenderness about one and one-half inches from the umbilicus, on a line extending from the navel to the anterior superior spine of the ilium.

In reference to this point and its diagnostic value, the conclusions of Hubbard are pertinent. He says that, "this tenderness is due to a tender lymph-gland, which has drained the region of the appendix, and there is nothing absolutely diagnostic in its presence. In acute appendicitis tenderness at Morris's point is of less importance than the symptoms caused by the appendix itself. However, in chronic appendicitis tenderness at Morris's point may be of distinct diagnostic value. Tenderness at this

Perman (80b) had in a report of appendix cases (appearing in the *Hygeia* for 1904, p 797) spoken of right sided pain produced by pressure in the left iliac region in a case of appendicitis At the present time this symptom-complex is known as Rovsing's sign The best way to obtain the pain is to lightly tap the abdomen on the left side, while the patient breathes quietly and relaxes the abdominal muscles

Perman argues with Hofman and Hausman that the pain is not due to the stretching of the cecum due to the pushing up of the colon contents, but rather to the pressure carried directly from the palpated to the inflamed area. If the sign is present, in chronic or in interval attacks of appendicitis, it is due to adhesions When present in acute attacks, the appendicitis is not simply a catarrhal form, but is a pathological case of the most severe kind, either a beginning phlegmonous infiltration or gangrene with threatening perforation. The sign may also be present in salpingitis. In a few of those cases and in pelvic peritonitis Perman (80b) has observed it.

Lauenstein (53b) also doubts the value of this sign, and believes that Rovsing also will in the future change his mind regarding its absolute significance.

point, even though the only physical sign, by the rule of chance, makes the diagnosis of appendicitis probable. When combined with tenderness at McBurney's point the diagnosis becomes more certain. Its absence does not rule out appendicitis, and its presence does not make the diagnosis of appendicitis absolute, for it may occur in other conditions besides appendicitis. The point has by no means the importance given it by Dr. Morris." (See areas of reflex tenderness, Head's zones, in appendicitis.) In hernia of the appendix the pain is more or less diffused around the umbilicus, or lies in the lower abdomen. It is described as colicky in character, sometimes as a dragging sensation which is felt in the right iliac fossa. (See the relationship between the dragging and the location of the pain, which is the same as in an early case of appendiceal inflammation.)

Symptoms Associated with Pain Production in Appendicitis. —*Rigidity of the right rectus* is an almost invariable accompaniment of appendiceal inflammation. It is most marked in the muscular segments located immediately above the appendix. Should rigidity suddenly increase, and become general over the entire abdomen, with a sudden increase of pain, it is an indication of a rupture of the appendix, or of a sudden spread of the inflammation, so that a generalized peritonitis has resulted.

Constipation is one of the associated symptoms of appendicitis. It is due to a reflex arising from the inflamed organ. Often the reflex peristalsis can be aroused in a normal intestine by the pressure of the bowl of the stethoscope. A weak or absent peristalsis is an indication of the spread of exacerbation of the inflammation.

Motion is generally interfered with; climbing the stairs is a source of pain, especially when the appendix lies upon the psoas muscle. The reason of the much greater pain when the patient is walking or climbing stairs is that, in these conditions, there is a concomitant contraction of the psoas muscle and the abdominal wall muscles, and the appendix, caught between the two, is subject to considerable pressure. Often the first indication of peritoneal pain has occurred during the drawing on of the shoes.

Posture.—In appendicitis the patient usually assumes a recumbent dorsal posture, with one limb, usually the right, drawn up, and in some cases lies with the right limb thrown over the left. In many, especially after an abscess formation, or when adhesions are present and the bowel segments are bound together, a left lateral posture is very painful; this is due to the drag and pull upon the adhesions by the weight of the bowel in this position. It is common for patients with appendicitis, when walking, to bend the body forward and step lightly.

Jarring, such as occurs in running and jumping, frequently causes pain. Any spasmodic movement of the diaphragm, such as takes place in vomiting, coughing, and sneezing, also gives rise to pain. Percussion of the abdomen also produces it, and it is claimed by Schmidt that often by this means the delimitation of pain is more accurate than by any other. The pain is greater when percussion is made directly over the median line than when it is made to either side, because here the protective action of the muscles to the abdominal viscera is lacking.

During appendicitis *pressure* on the abdomen is very painful, particularly so if to the appendicitis peritonitis has been added. When this ensues vomiting generally occurs. In some cases of appendicitis, pain can be produced by palpation upon the opposite side of the abdomen. Another means of diagnosing appendicitis is to *distend the colon* with gas. As soon as the gaseous distention reaches the appendiceal region, pain is produced by disturbance of the cecal relationship if peritonitis is present, or by appendiceal distention should only the appendix be involved. However, this is a dangerous procedure, and should be used, if at all, only in chronic cases.

Sudden increase in the sensibility to pressure is indicative of extension of the inflammation. The sensibility may be so great that even the weight of the bed-clothes is unbearable. In some cases distention of the bowel may also cause great sensitiveness to pressure. Pain on pressure under the costal margin is chiefly of peritoneal origin.

The pain of appendicitis, in many cases, seems to be induced by *peristalsis.* Many a sufferer has been aroused in the middle of the night by the most severe cramps, which the later progress of the case proves to be of appendiceal origin. These come on at the time intestinal peristalsis is most active, that is, from five to seven hours after eating. In some cases the ingestion of cold food or drinks will incite active peristalsis and thus cause pain (Schmidt).

Differential Diagnosis.—The pain of appendicitis should be diagnosed from: *colitis*, which generally is not productive of pain; but if it is, the accompanying diarrhea, with its content of mucus, is sufficient for a diagnosis; *intussusception*, in case of tumor formation. It is very difficult, in many cases, particularly when pain is very severe, to decide whether the condition is one of appendicitis or intussusception, especially so should the condition be associated with vomiting and constipation.

Gall-bladder and *gall-stone colic pain* may be diagnosed by the higher area of cutaneous hyperalgesia; also by the area of local tenderness present in these conditions. *Typhoid fever*, especially when it is of sudden onset and commences as an acute abdominal pain, has on more than one occasion been mistaken for appendicitis, and the patient has been operated on under that mistaken diagnosis, in some cases with disastrous results. Generally, in these diseases (typhoid), the pain, while severe, is still bearable, and, as a rule, there is not present any considerable amount of abdominal rigidity. The temperature also is of the ordinary typhoidal type, high in the evening and low in the morning, while in appendicitis it is more constant. The blood count in typhoid is also low in leukocytes, while generally, in appendicitis, it is high. Should the pain occur later in the disease (about the third week), and be associated with abdominal rigidity, perforation should be sought and careful inquiry should be made as to the type and character of the pain. A constant, spreading pain, very sharp and severe, generally indicates a spreading peritonitis.

Ovarian and Tubal Disease.—In the diagnosis of appendicitis from right salpingitis or oophoritis, the presence on the right side of tenderness, which is increased and, at the same time, is associated with subjective pain at the menstrual period, is a criterion of worth. In those conditions which closely simulate both appendicitis and ovarian or tubal involvement, it must not be forgotten that either or all may simultaneously exist, and that, if they do so, symptoms of one or of all three may be present. If all of these organs are acutely inflamed, adhesions will remain after the inflammation subsides, and these adhesions will be a potent cause for pain production in the future. A point of some importance to remember is that pains due to involvement of the genitalia are never, or very seldom, influenced by the ingestion of food. Vaginal examination may help to clear the diagnosis, though when the appendix is in the pelvis it may be difficult to differentiate appendicitis from tubal disease.

Hydronephrosis has been mistaken for appendicitis, but the urinary symptoms of the former, with the history of the disease, should render easy the diagnosis.

Ureteral calculus has a pain that is very sharp and severe, and soon after the cessation of the pain, or, if the attack is prolonged, during it, blood may be present in the urine.

Sciatica could hardly be mistaken for appendicitis, though appendicitis with referred or reflex pain down the back of the thigh has been mistaken for sciatica.

Carcinoma of the cecum is a condition associated with tumor, emaciation, and signs of a gradually increasing intestinal obstruction.

Lumbago can hardly be confused with appendicitis, even in those cases in which appendiceal referred pain is felt in the back.

Peritonitis has been mistaken for appendicitis. This can hardly happen with a careful observer, for the bilateral and deep tenderness, generalized, with tenderness on vaginal and rectal examination cannot but be interpreted as due to peritoneal involvement. *Tuberculous peritonitis*, in which the lesions are confined to the cecum, is very difficult to diagnose from chronic appendicitis. The more chronic course, the tuberculin reaction, the presence of a focus of tuberculosis elsewhere, the very slow onset, with no history of an acute attack, are diagnostic criteria of very great value.

Extrauterine pregnancy has also been mistaken for appendicitis, but the presence of fluid in the cul-de-sac of Douglas, the history of pregnancy, the presence of anemia, and the passage of some bloody discharge from the uterus help in the diagnosis.

Erythema exudativum multiforme sometimes causes a pain resembling appendiceal crises.

Sagging loops of intestine, or omentum, by pressure upon the external abdominal ring, produce pains that closely resemble those experienced in chronic appendicitis.

Cheinisse (454, pp. 1-12) describes a condition which is frequently associated with syphilis, influenza, or hysteria, in which there is considerable pain around McBurney's point. The diagnostic differentiating points are: the absence of leukocytosis, fever, and rapid pulse. Painful points may also exist at the exit of certain nerves. The abdominal wall, also, is not rigid, and the pain, as a rule, is not confined to one definite location. A variable tumor is felt.

CHAPTER XXVI

THE LIVER, GALL BLADDER AND DUCTS

GENERAL CONSIDERATIONS

The liver is the largest gland in the body. It is subject to diseases similar to those of other glands, and also to additional disturbances, functional and anatomical, due to its different structure and function and to its intimate relationship with the digestive apparatus.

The painful disorders affecting the liver as a glandular organ are congestion, inflammation, adhesion, and displacement.

The painful disorders affecting the liver and gall-bladder because of modified structure are inflammation of the gall bladder, inflammation of the ducts, obstruction of the ducts by foreign bodies or new growths, adhesions, etc.

Nerve Supply.—The nerve supply to the liver is sympathetic. It does not, as many have thought, derive through its convex surface a partial supply from the branches of the intercostal nerves distributed to the dome of the diaphragm, nor does it have any connection with the phrenic, Ranstrom being unable to trace a single branch of the phrenic nerve through the suspensorium ligament to the capsule of the liver, also no twigs from the intercostals could be found extending to the surface of the liver. The sympathetic fibers are derived mostly from adjacent sympathetic plexi and ganglia (cœliacum, etc.), which in turn are connected with well-defined segments of the cord. The cord segments involved in diseases of the liver proper are the eighth and ninth, and sometimes the tenth dorsal, while the fifth, sixth and seventh dorsal segments are involved in disease of the gall bladder. The outlines of the segments, with their maximal points of tenderness, are shown in the annexed figures. The maximal points of tenderness

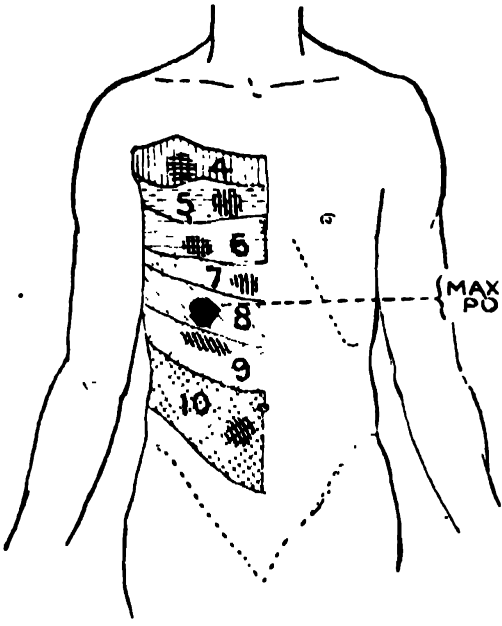

FIG. 122.—AREAS OF REFERRED PAIN IN LIVER DISEASE: ANTERIOR VIEW. (According to Head.)

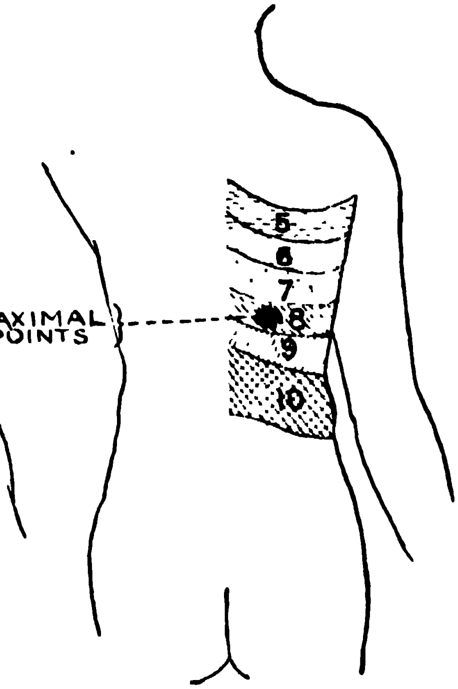

FIG. 123. AREAS OF REFERRED PAIN IN LIVER DISEASE: POSTERIOR VIEW. (According to Head.)

of these zones closely correspond with the areas in which pain and tenderness are felt in diseases of the liver and gall gladder.

The vagus also assists in the liver innervation (Edgeworth). In some cases of common duct disease, especially when the area near the junction of the hepatic and cystic duct is involved, the pain-producing stimulus is carried through the branch from the adjacent sympathetic plexus to the left vagus, and thence to the fourth and sixth dorsal segments, from whence it is reflected to the chest wall in the distribution area of these segments. This explains why pain is sometimes felt in the left anterior wall of the chest, at about the level of the fourth or fifth costal cartilage.

The accompanying sketch (Fig. 125) shows how pain irritative sensation may be carried from the vicinity of the hepatic duct to the vagus, and thence be propagated through the sixth or fourth ganglia of the sympathetic to the adjacent cord section, from whence it is carried to the brain, and is felt as coming from the somatic distribution area of these segments. The maximal points of tenderness in these segments are shown in Figs. 122 and 123.

Pain in the right shoulder in liver disease is transferred through the right phrenic. This happens when the diaphragm is involved by a lymphangitis spreading from an inflamed liver or gall bladder. The drawing on the next page shows the paths of communication between the liver and the cord.

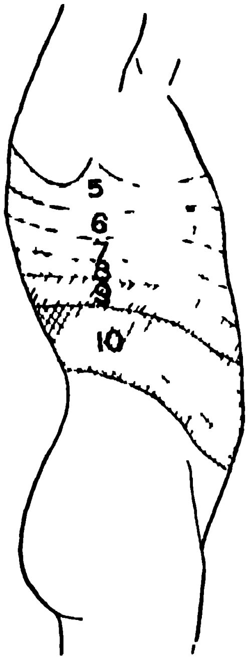

FIG. 124.—AREAS OF REFERRED PAIN IN LIVER DISEASE: LATERAL VIEW. (According to Head.)

The liver itself is not very sensitive to pain-producing stimuli, for Lennander was able to apply a strong faradic or galvanic current to the surface of the liver above the gall bladder without exciting pain. He also claims to have separated the gall bladder from the liver as far as the cystic duct without the production of pain. The sensations of pressure, cold and heat are absent from the liver, as well as from the stomach and intestines. However, tilting of the liver, or pulling on the common duct, will cause pain.

According to Mayo, the most sensitive area in the liver is in the vicinity of the common bile duct about the neck of the gall bladder. This area receives filaments from the eleventh and twelfth dorsal, and the first lumbar nerves. These nerves also supply the diaphragm, and this relationship probably accounts for the spasm of the diaphragm so often associated with gall-stone colic. It also accounts for the disturbance of diaphragmatic action, even under deep anesthesia, when in operating in this region pressure is made on this area. Murphy's[1] sign owes its presence to this reaction; for as soon as the sensitive area around the gall bladder is pressed against the examiner's fingers, there is a sudden restriction of inspiration, and the characteristic grunt or groan as described by Murphy occurs.

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[1] For a description of Murphy's method of eliciting this tenderness, see under Gall Bladder Disease.

The liver, as has been shown, is supplied by both the sympathetic and the cerebrospinal nerves. Its cerebrospinal nerve supply is derived from the left vagus through a communicating branch which passes from the nerve plexus on the anterior surface of the stomach; thence it is distributed to the substance of

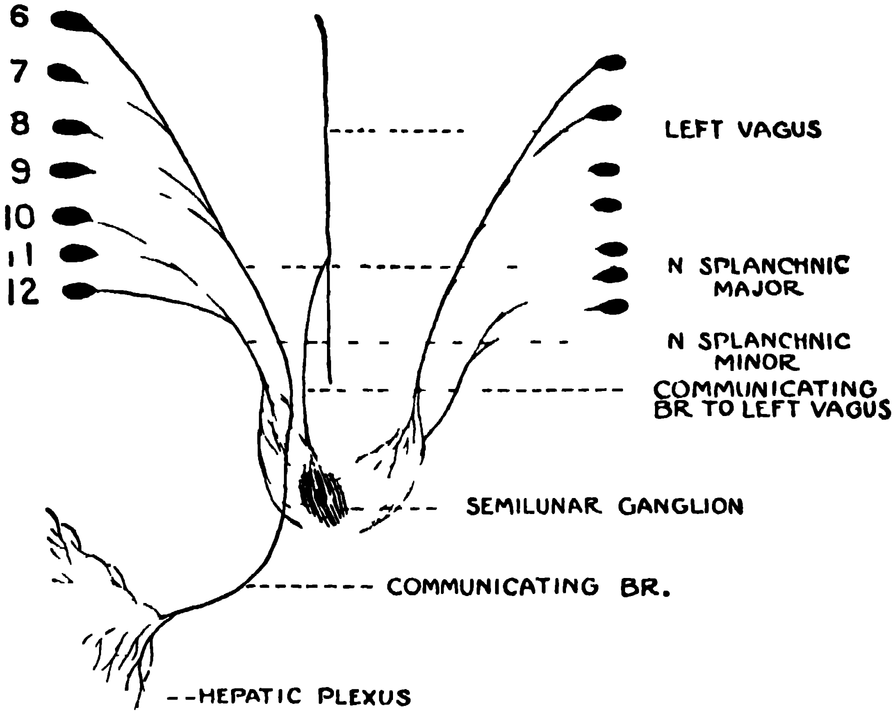

FIG. 125.—RELATIONSHIP OF NERVE SUPPLY OF LIVER TO CEREBROSPINAL AND SYMPATHETIC SYSTEMS.

the liver through the ligamentum hepatico-duodenale to the transverse fissure. The nerves accompany the arteries and are distributed in their walls. This is important to remember, for it has a definite bearing on the production of pain in congestive states of the liver.

Examination for Pain. The grade of intensity of pain is of little guiding moment in the diagnosis of diseases of the liver or of its appendages. In many of these cases the patient is abnormally sensitive and is most irritable, so that a variety of subjective symptoms, either painful or otherwise, are experienced. Under these circumstances, local tenderness is most useful in defining diseases of these organs. It may be elicited by: (1) palpation, (2) percussion, and (3) sensibility examination. Palpation is of the most value and is the method universally employed, the use of the other two being, as a rule, confined to those who are accustomed to employ in their examinations the refinements of modern technique. Palpation should be attempted only with the patient reclining, with the abdomen flaccid, and the knees drawn up.[1]

With the abdomen relaxed the hand is placed flat upon the anterior surface with the finger tips directed toward the liver. For this purpose it is best to use the right hand and to stand at the right of the patient. The tips of the fingers may now be pressed into the abdominal wall below the costal arch at about the level of the ninth or tenth rib, and the patient is requested to take a deep inspiration. If, during or at the acme of inspiration, pain is felt, it is an indication of either a perihepatitis or a gall-bladder disorder. The fingers should then be removed to the area of the gall bladder; the patient is raised to a sitting posture and another deep inspiration is taken. Should there occur a sudden stopping of the inspiratory movement, accompanied by a grunt, gall-bladder disease is indicated. If nothing special is noticed on this procedure the patient is again directed to lie flat, and the right hand is placed on the back below the liver, while the left is placed above and over the liver. Firm pressure is now made between the two hands and at the same time the patient is instructed to breathe deeply. Should a perihepatitis be present the patient will complain of severe pain, which sometimes radiates to the front of the right shoulder. Nodular growths on the surface of the liver, tender on pressure, may often be felt in malignant disease of the liver. They are present along the lower margin and the convex surface.

Percussion is of less value than is palpation as a means of eliciting pain phenomena in the diagnosis of diseases of the liver or of its appendages. If the liver is involved, percussion is painful over the entire liver area, and, to a slight extent, beyond it.

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[1] Should the patient be unable to relax the abdomen, because, perhaps of an associated peritonitis, palpation is of no value.

If the gall bladder alone is involved diffuse tenderness extends around a much smaller area of maximum local tenderness as a center, the maximum tenderness corresponding to the location of the gall bladder. The cause of this considerable extension of tenderness is probably to be explained by the range of vibration produced by the percussion stroke; for even though the blow is made over an area which is not diseased the vibration may be communicated to an adjacent diseased area, and thus cause pain.

In congestion of the liver, percussion in the epigastrium is productive of pain. This pain extends from the ensiform cartilage to the lower margin of the liver.

Sensibility Examination.—Examination to light touch, pin-point and related sensory tests are of value in localizing the areas of hyperalgesia, which are identical with the areas of reflected pain, as elucidated by Head. These areas are particularly useful in defining lesions which do not give rise to any acute symptoms, such as abscess of the liver, cholecystitis not involving the peritoneum and cirrhosis.

In some cases of liver, gall-bladder and duct disease the pain persists after the removal of the pathological lesion originally causing it. This persistence, the so-called habit-pain, is, no doubt, due to some pathological change in the nerve supply to these parts, by which the excitability to stimuli is increased to such an extent that reaction to a painfully excessive degree occurs on the slightest irritation. This excitability, which was originally due to the pathological lesion, remains for some time as a habit-state after the original cause has been removed.

PAIN OF THE LIVER

Character of the Pain.—In disease of the liver the pain, if present, is generally of a dull nature, while in involvement of the ducts the pain is of an intermittent, colicky character, and is much more intense and severe than it is in disease of the liver proper.

Relation to the Ingestion of Food and Drink.—The ingestion of food does not seem to have such an intimate relation to the production of pain in disorders of the liver and its appendages as it does in disorders of the gastrointestinal tract proper, but that it is not entirely without influence is apparent. In nearly all of the diseases to which the liver, the gall bladder or its ducts are subject the movement of peristalsis and the augmentation of the circulation, which the ingestion of food produces, cause pain. The degree of pain from these factors depends considerably upon the extent to which the liver structures are involved and particularly on the manner of the involvement. Should a perihepatitis be present or adhesions have formed, increased peristalsis and increase in the portal blood pressure in the liver will cause more pain than if an abscess or a cirrhosis constitute the entire pathology; consequently it is in the lesions of most acute and recent formation that the pain variation is most influenced by food ingestion.

The ingestion of food also causes pain in a simple inflammation of the gall bladder or of the ducts. The manner of the pain production may be explained on two hypotheses:

(1) That there is an intimate nervous connection between the gall bladder, its ducts, the stomach and duodenum, so that when peristalsis is excited in the latter organs there is, at the same time, a reflex peristalsis produced in the gall bladder and ducts. Should the ducts or gall bladder be inflamed pain is likely to result.

(2) Owing to the intimate relationship of all the structures in the upper abdomen, an increase of peristalsis in the stomach or the duodenum will, by pressure or dragging (from adhesions already formed), produce pain in the neighboring inflamed bladder and ducts. Therefore, if pain in the liver, gall bladder or duct areas or zones is present after the ingestion of food, inflammation or adhesions should at once be sought.

Schmidt (p. 215), in speaking of the relationship of food to the production of pain in liver, gall-bladder, or gall-duct disease, says that "the taking of food is important only in those cases where we are dealing with delicate, anemic individuals, often with some degree of enteroptosis, especially those with gastroptosis and general atony of the stomach." It does not seem that the kind and character of the food, except when it is so indigestible that it leads to vomiting, have as much influence on the production of gall-bladder and duct pains as does the quantity, where it acts more as a mechanical agent, producing pain from its proximal pressure. In case the pain is of inflammatory origin, cold drinks seem to ease it.

Relation to the Movement of the Body.— It may be stated as an axiom that when, in disease of the liver or its adnexa, pain is produced by movement, such as bending, stooping, and rapid or forcible breathing, inflammation is present; while, should these movements, including change of position, not produce or increase the pain, it may be accepted as a fact that inflammation is absent and that any spontaneous pain which may be felt is due to stone, or to some disease causing a slow tissue change, as cirrhosis. It seems that in inflammatory diseases of the hollow viscera deliberate movements and change of position are not particularly painful, but that rapid movements, especially those involving a jar, are productive of great pain. Movements such as occur in running, jumping, riding horseback, traveling in springless wagons, going up or down stairs, and some movements connected with respiration, such as sneezing, coughing, and yawning, are very painful. Positions causing intraabdominal pressure are also painful; for example, the bending of the body, stooping, and defecation.

Position of the Body.—In inflammatory diseases of the liver the patient tries, as much as possible, to inhibit motion and to avoid everything which causes dragging upon the liver and its attachments, as this causes pain. To do this he generally lies in bed upon his right side. It might be urged that this is a very poor position for him to assume in order to acquire ease, for in it the pressure from the abdominal viscera is greatest upon the inflamed liver, gall bladder, and ducts, and consequently one would think that the pain should be greatest. It is very true that in such a posture there is great pressure on the liver, etc., but it should be recalled that the assumption of the left lateral posture would put considerable traction upon the ligaments, which, being inflamed, would cause pronounced pain. This pain is so much greater than the pain produced by the intraabdominal pressure, when the patient lies upon the right side, that naturally he assumes the posture of relatively greatest ease. In general, it may be said that more comfort is obtained in reclining than in the upright or sitting posture. This, according to Schmidt, is due to the much better draining of the liver when the body is in a reclining position.

Likewise in malignant disease of the liver, or in hepatic hypertrophy or enlargement from any cause, the patient has the greatest ease in the right lateral position, for turning upon the left side causes a great increase in the pull and drag upon the ligaments by the enlarged and weighty organ. This is especially noticeable in multiparæ, because of the relaxation of the abdominal wall. Generally, in these conditions, the patient likes to lie upon his back, because this is the posture of greatest ease. If nausea and vomiting also occur on change of position, some additional pathological process in the stomach or intestine should be sought.

Relationship to Other Diseases and Processes.—Gall-bladder colic is often initiated by psychic and emotional disturbances. It is also suggested that it may be reflexly started by impulses arising in other organs, such as the kidney, genitals, stomach, or intestines. Constipation also seems to initiate an attack. Should pain occur in the liver area during pregnancy, or shortly after its termination, either the gall bladder or the liver may be affected. It seems to be fairly common that the gall bladder, immediately after labor, becomes intolerant of its gall-stone contents, and tries to force them out through the narrow duct, thus producing pain and distress, the so-called gall-duct colic. During pregnancy, also, the liver is subject to metabolic and toxic changes. A degeneration of liver tissue leading to atrophy may result in the well-known yellow atrophy. While the pathologic changes associated with this disease are, as a rule, painless, yet in many cases, because of parenchymatous or peripheral inflammation, pain may be a prominent symptom.

Typhoid fever, at times, in its early stages produces symptoms resembling cholecystitis, and, in some instances, gall-bladder inflammation very likely is present. When symptoms of cholecystitis do occur in typhoid fever they last only for a few days, and then become merged into those typical of the fever. During convalescence pain and tenderness over the gall-bladder area may also occur, and in these circumstances they indicate gall-bladder infection. Should the inflammation become so severe as to require operation, the gall bladder is found to be inflamed, and in many cases filled with pus.

Liver disorders occurring during the course of dysentery, particularly that due to amœba coli, should at once cause a search to be made for liver abscess. Enteroptosis may be associated with gall-duct disease, and the pull and drag upon the liver and its appendages, produced by jarring, running, or jumping, may, especially if a movable right kidney i present, incite a gall-duct colic in one who is subject to such attacks.

Time of Appearance of Pain.—Liver and appendage pain is generally incited or at least made worse by the onset of digestion, particularly after the food passes through the pylorus and enters the small intestine. This, as a rule, occurs from two to four hours after eating.

Gall-stone pain generally occurs in paroxysms. The pain paroxysms may be incited by vomiting and by excessive motion.[1] Should a colic resembling gall-stone colic appear in a person of advanced age, it is more likely that the condition is one of carcinoma of the gall-bladder than a cholelithiasis. Gall-stone colic, like all other colics, seemingly has a tendency to occur most frequently at night. This possibly is only a supposition (see Diurnal Variation of Pain). If the pain is due to a hepatitis it may last for a long time, the constant pain being interrupted by exacerbations, which indicate the flaring up of a dormant infection. In gall-stone colic, on the other hand, the pain is not so continuous, but occurs in paroxysms, which disappear on the passage of the stone or on its retrogression into the gall bladder. In these cases there is generally a history of a previous attack, with a similar pain, accompanied by vomiting, jaundice, light-colored stools, bile in the urine, and constipation. A history of gastric disturbances, associated with pain in the right hypochondrium, should, in all cases, lead to the suspicion of gall stones as the cause of the disorder.

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[1] Gall stones may lie latent in a gall bladder for years until, suddenly, the patient has an attack of indigestion and the latent disturbance at once becomes active. The violent retching and vomiting which accompany the indigestion have dislodged the calculi from their resting place in the bladder and one or more are forced into the cystic duct, thus causing the pain.

Neuralgia. Sometimes the nerves supplying the liver, it is said, are subject to what is called neuralgia. Allbut describes such a state of the liver, but Maylard doubts its existence. The latter observer quotes a case, but the signs and symptoms which he noted seem to be rather those of a hepatitis than of a neuralgia. The case quoted by Maylard from Allbut is as follows:

"Mr. W. A. - , aged 32, whose habits are temperate, whose health is exceptionally good, and who presents no obvious disorder of function, has called upon me at intervals for three years. Four months before his first visit he was taken with a pain which he refers precisely to the seat and extent of the liver. This pain has often recurred, and observes no period of recurrence, except that it always attacks him at night. It is a 'miserable pain.' He arises and paces the floor for hours. He maps out the liver, of whose seat he was previously ignorant, with curious exactness. He has had no jaundice, nor does he suffer from constipation. The pain does not stab nor radiate as spinal pains do. On bromid and arsenic he recovered and was well for twelve months, when worry and overwork recalled the attacks. The family history points to rheumatism."

Pains Due to the Disturbance of the Liver Substance Proper.—The pains due to disturbance in the liver proper are either extra- or intraparenchymatous in origin.

(1) Extraparenchymatous pains are caused by (a) distention of the capsule; (b) inflammation of the capsule by inflammatory products, etc.; (c) traction from adhesions joining the capsule

to adjacent organs, or to the parietal peritoneum; (d) traction by the liver on adjacent organs through its ligaments, because of displacement.

(2) Intraparenchymatous pains are produced by irritation of the nerves in the liver substances by inflammatory products, tumors, etc. The stimulus is carried by means of the sympathetic fibers, whence, depending mostly upon the strength of the stimulus, it is generally reflected to the body wall and is there perceived as pain.

INTRAPARENCHYMATOUS PAIN. *Distention of the liver* causes pain, especially when the enlargement is acute. Chronic disorders of the liver causing an increase of the parenchyma (of substance mass) are, as a rule, not painful.[1]

The principal causes of acute distention of the liver are passive and active congestion. Passive congestion is due to a backward stasis, either in the blood circulatory system (hepatic or portal vein), or in the bile circulatory system, such as is produced by closure of the lumen of the bile ducts from inflammatory swelling or gall stones. Acute distention, the result of active congestion of the liver with involvement of the parenchymatous nerves, occurs in abscesses (toxic or pyemic), in rapid-growing cancer and sarcoma, and in acute generalized inflammation of the liver substance. In these conditions there is present an interstitial hepatitis, and this adds considerably to the pain content by irritating the local nerves. Acute distention of the liver may also be caused by active hyperemia of the liver, the result of overeating.

Patients subject to a *hepatic congestion*, due to a stasis, generally complain of a sense of pressure in the liver region. Pain, if present, is more of a dull ache around the costal arch of the right side. Referred pains are not common in this class of disorders. The pain is made worse by any exertion of the patient, such as going up stairs, running, and walking, while it markedly decreases when the patient, and consequently the heart, is in a state of rest. The pain is also worse when the patient is in an upright position, and is increased by deep breathing, by the ingestion of certain kinds of food, such as albumins, and by the drinking of alcoholic liquors. It is also made worse by a sudden change of position and by lying on the right side.

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[1] It is claimed by Schmidt that distention of the liver capsule is a cause of pain production in malaria, pernicious anemia, paroxysmal hemoglobinuria, leukemia, and diabetes.

According to Murchison there are present in congestion of the liver: (1) a feeling of tightness in the liver region; (2) more or less tenderness, rarely acute on pressure below the margins of the ribs on the right side; (3) a pain which may extend up to the right shoulder and which is increased after meals. According to the same author, lying on the left side produces a feeling of dragging or weight in the hepatic region. Pressure on or percussion over the liver area is painful. According to Schmidt the maximum pain is felt in percussion along the linea alba and extends in this line from the tip of the ensiform down to the liver margin. He also claims that the tenderness to percussion, in a case of backward congestion from a non-compensating heart, will, when under treatment with digitalis, become less as improvement occurs.

Another differential point is that the pain of congestion, unlike that of hepatitis, is rarely referred to the right shoulder or scapula. When acute congestion occurs the liver becomes larger and harder. The patient may be aware of this change, the exact nature of which he does not understand, for he often complains of the increasing hardness of the abdomen.

In *passive* congestion of the liver, pain and tenderness are not prominent factors, unless the congestion is sudden in its onset, for the passive congestions of slow onset gradually distend the capsule, which, without pain, accommodates itself to the increase in the intracapsular bulk. A pathognomonic sign of backward (stasis) congestion is expansile pulsation of the liver, systolic in time.

A liver which already is afflicted with cirrhosis cannot become congested. Therefore, if passive congestion is general and it does not appear in the liver a diagnosis of cirrhotic liver may be made. Should perihepatitis ensue during passive congestion of the liver the pain of the congestion is aggravated by the much more acute and severe pain of the perihepatitis (q. v.).

Besides the congestion due to the backward stasis of blood, a biliary stasis may also occur, but this is not of such a type that pain is common. The pressure from the retained bile generally is not sufficient to distend the liver capsule and cause pain. It acts especially as a predisposing cause for pain production, for the biliary stagnation produces a condition favorable to inflammatory reaction, which may ensue and turn the passive congestion into an active inflammation.

Congestion due to acute inflammatory lesions causes both a distention of and an irritation of the capsule. This irritation may be productive of a very mild or a very severe inflammation, which in turn may result in the formation of adhesions. There is also a great tendency for infectious inflammatory diseases of the liver to form *abscesses*. The abscesses are of two types: (a) pyemic and (b) tropical. The *pyemic abscesses* are generally small and multiple and are painful only because of the secondary changes which they induce.

Some of the abscesses are near the peritoneal surface, and as a consequence they involve this membrane. Adhesions quickly form, and much of the pain is due to the traction exerted upon them by the liver. A description of the pain due to a single abscess and its complications is given by Hotchkiss, New York Surgical Society, March 10, 1909. He says:

"The onset of the condition began as a pain in the epigastrium, which lasted for two days without relief; but after this it was less severe and lasted for two years, being modified by the kind of food which the patient ate. It came on in the morning when he woke up, was confined to the epigastrium, did not radiate, and was often relieved by a cup of hot fluid, such as tea. The pain always returned after the other meals, but was not as severe, and generally was relieved by pressure and hot drinks. It was worse when lying on the side; also, after the taking of solid food and after exercise. On physical examination there was an area of tenderness and muscular spasm over the upper segment of the right rectus muscle. An abscess was found in the central part of the liver, adhesions to the diaphragm being present."

The pain in these conditions in which the liver is bound to the diaphragm or to the abdominal wall by adhesions is increased by coughing, sneezing, and deep breathing. The respirations, because of the pain, are generally short and rapid. Tenderness over the abscess area is, as a rule, present.

Tropical abscess is generally free from pain; because, in the first place, it is of slow development and is in the interior of the liver; and, secondly, because it is free from inflammatory reaction. Should it progress toward the surface and the peritoneum become involved, pain is produced. If it is on the convex surface and involves the diaphragm pain over the right shoulder is also a prominent symptom.

In *cirrhosis of the liver* the pain, if present, is due chiefly to an associated neuritis, which may be caused either by previous alcoholism or by the toxemia which is associated with this disease. This neuritis is confined principally to the arms and the legs.

In biliary cirrhosis there is generally a sense of weight in the right hypochondrium; and periodic attacks of pain with tenderness over the liver and spleen occur.

New Growths. In new growths of the liver pain production seems to depend upon two factors: (1) the location of the growth in reference to the capsule of the liver, and (2) the rapidity of the growth.

Growths which involve the capsule are generally more painful than those which occur in the substance of the gland. When the growth is superficial a certain amount of perihepatitis is to be expected, and this not only causes pain directly, but also indirectly, by the adhesions which are produced. According to Rolleston the pain due to malignant disease may be almost constant in the right hypochondrium, but often is especially marked in the back, in the shoulder, or in the loin. It often occurs in paroxysms, frequently radiates to the right shoulder, and is worse at night (characteristic). Early in the disease there is only a sense of discomfort or dragging, pain being a later result of the process.

Should the growths occur around the common duct symptoms resembling gall-stone colic are produced. Tenderness is well marked in growths of rapid development. This tenderness is frequently a sign of the associated perihepatic inflammation.

Cysts, especially hydatid, in the liver and its appendages are causes of pain. The pain in these conditions is not marked, unless the growth is rapid or the peritoneum is involved. In the first instance the pain is dull and aching and is due to distention of the liver capsule. In the second it is the result of peritonitis, is sharper and more acute, and is definitely localized to the upper abdomen. In cystic formation the abdomen over the margin of the liver is tender and often the irregular nodosities of the cystic growths can be felt. Sometimes the passage of small cysts through the cystic and common duct produces a typical gall-duct colic (Schmidt). These attacks, like those of calculi colic, are most common during the night, and the pain is worse in the left lateral posture. The onset of hiccoughs indicates diaphragmatic involvement. Syncope is common. The presence of booklets in the fluid removed by exploratory puncture is confirmative of the condition. Tenderness is generally a sign of suppuration. When this occurs there are a rapid pulse and an elevation of temperature. In some cases, owing to pressure on the stomach and intestines, symptoms of obstruction of either one or of both of these two organs may supervene. The rapidity of the growth influences to a great extent the intensity of the resulting pain.

Growths of slow development generally are painless, because with the slow increase in size the adjacent liver cells, having had an opportunity to adjust themselves to changed surroundings, give rise to no physical or economic disturbances. In growths of rapid development, however, this does not occur, nor has the capsule had an opportunity to adjust itself to excess of pressure, and so pain is produced.

Secondary (metastatic) growths in the pleura and the peritoneum also cause considerable disturbance. The pain and local tenderness, the results of these conditions, generally follow, by a noticeable interval, the pains and tenderness due to the primary growth. Sometimes the common or cystic duct may be partially occluded by the growth. Then biliary colic is added to the symptoms already present. In some cases gall stones are present as a complication, and these add their own particular syndrome to the symptom-complex.

Rapid progress of the disease is an indication that the growth is probably of a primary nature. This belief is strengthened if the pain first complained of was in the liver region. Should the cancer be primary death generally occurs in three or four months. Even in growths involving the liver secondarily, death generally occurs within six months of the involvement.

Malignant disease of the liver, which, as a rule, is painful, is frequently confused with cirrhosis, which is painless. Other diagnostic points are: that in cirrhosis the spleen and liver are both enlarged; also in cirrhosis the liver enlargement is more uniform than in malignant disease and cachexia is less marked. If in malignant disease of the liver pain should be felt in the epigastrium and vary with the ingestion of food, a secondary involvement of the stomach is very likely present. Growths in the liver, secondary to cancer of the stomach, or of the intestine, are generally more painful than secondary growths in other locations, because the accompanying inflammation is much greater.

In the secondary involvement of the liver the pain follows that caused by the primary growth, wherever that may have been. Should the primary growth have been in the stomach the primary pain would indicate stomach involvement; and this, in case of liver metastasis, would be followed in an appreciable interval by pain in the region of the liver or gall-bladder.

Syphilis of the liver is indicated by attacks of pain, rapid increase in size of the liver, and by fever. The enlarged liver is tender, and has an uneven surface. The left lobe is more frequently affected than the right, therefore the left-sided localization of the pain under the left hypochondrium. There is also a certain amount of inflammatory reaction accompanying all syphilitic growths, and this in turn causes inflammation of the covering of the liver (perihepatitis) and of the adjacent peritoneum.

In view of these facts, it is hardly necessary to add that in all cases of pain in the liver area, with enlargement of the liver, syphilis should at least be considered and the Wassermann reaction determined.

EXTRAPARENCHYMATOUS PAIN.—*Perihepatitis.*—Intimately associated with the foregoing disorders, and generally following as the result of one or the other of them, is *inflammation of the capsule of the liver,* the so-called perihepatitis. Of these, there are two varieties, the acute and the chronic. The acute variety as a primary condition is never met with in the temperate zone. It has been found as a primary disorder in the tropics, because the congested state of the liver in inhabitants of these regions easily lends itself to an inflammatory process. The inflammation originates from local extension of a diseased process, either from within the liver substance (acute hepatitis, abscess, new growths) or from some adjacent viscera. In both the acute and chronic form of perihepatitis a friction rub is generally heard over the liver region on auscultation. It may also be felt on palpation over the same area.

The extrahepatic disorders from which perihepatitis may result are: peritonitis in the lesser or greater peritoneal sac; rupture of viscera adjacent to the liver, as the gall bladder, stomach, or duodenum; and inflammation of adjacent viscera. Here the inflammation is communicated to the peritoneum, or to the connecting ligaments, and thus is transferred to the liver capsule (Roberts). In any of these conditions the character of the pain present previous to the perihepatitis may give some idea of the primary source of involvement.

In some intrahepatic lesions pain is not present, although, as a rule, some discomfort is experienced.

Acute Hepatitis.—The pain in acute hepatitis is quite sudden in its onset, while that of the chronic variety is of a more gradual development. In either case the pain is directly over the liver and is made worse by such motions as occur in respiration, in changing the position of the body, or in contraction of the abdominal muscles. The liver is also tender to the touch. A method of palpation suitable to define this condition is to place one hand on the hypochondrium over the liver and the other on the back underneath the liver. Now make a to-and-fro motion with the two hands, when, if hepatitis is present, pain will result. Besides this local pain there is also present a referred pain, felt in the right shoulder, in the area between the clavicle and the acromion process of the scapula on the front of the chest (Cantli).

Displacement of the Liver.—A further cause of hepatic pain is traction on adjacent organs by an enlarged liver through its ligaments. These ligaments are five in number: the falciform or suspensory ligament, the round ligament, the two lateral ligaments, and the ligamentum venosum. Any or all of these may be stretched or pulled upon in liver displacement.

In liver displacement (hepatoptosis) the liver may be rotated in one of two directions: around the transverse axis, so that its upper, convex surface becomes anterior; or around the vertical axis, either to the left or to the right. The latter is the more common. In this the right lobe becomes inferior, and the inferior surface is turned to the left. In a left-sided rotation the left lobe becomes the lower, and the inferior surface is turned to the right. Rotation to the left will produce more traction on the ligaments connected with the left lobe of the liver, while rotation to the right will cause traction to be exerted on the ligaments connected with the right lobe. In either case the pull is chiefly upon the diaphragm and has about the same degree of force, irrespective of the direction of the turning. The traction due to rotation will produce the same diaphragmatic symptoms as a downward displacement of the liver (q. v.).

Downward displacement of the liver will produce: (1) a pull on the diaphragm; (2) a pull on the left vena cava; (3) a rotation and angulation of the portal vein, hepatic artery, and common duct; (4) a slight rotation of the upper pole of the right kidney; and (5) a compression of organs below the liver.

The pull on the diaphragm which is exerted through the falciform ligament, which is almost in the center of the diaphragm, and through the coronary and triangular ligaments, which are to the right of the median line, will produce traction on the right half of the diaphragm, and thence through the diaphragmatic attachment, on the right ribs. This is felt as a dragging sensation, or discomfort, in the right lower chest at the points of insertion of the diaphragm on the six lower ribs.

Because of the pull on the vena cava, traction is propagated up into the chest underneath the sternum, even as far as the base of the heart. Here the inferior cava, because of its intimate association with other structure, is firmly fixed, and, as a consequence, it is at this point that the greatest traction is made and the pain, which is referred to the anterior chest wall, is produced. In other cases the pain is propagated further, being transmitted through the cervical fascia and is felt as high as the base of the neck.

Owing to the rotation of the liver, a twist or angulation of the portal vein, hepatic artery, or the common or cystic bile duct may occur. A twist and partial occlusion of the portal vein or hepatic artery may not, of necessity, be provocative of pain, though an occlusion of any of the bile ducts, provided it is acute, is almost sure to be. When an occlusion of the ducts occurs, the pain may be due directly to the occlusion, or the occlusion may lead indirectly to pain production from the tendency, when stagnation of bile takes place, to the formation of gall stones.

The rotation of the kidney may cause the renal colic sometimes present in hepatic displacement. The liver, when it is displaced, causes, through its ligamentous attachments to the upper pole of the right kidney, a downward and inward rotation of the upper pole of the kidney, with a tendency to, and sometimes an actual, kinking of the ureter. This is the cause of the pain.

All the pains due to hepatoptosis are relieved when the patient assumes the reclining posture and are increased in the upright position. When the pain is not relieved by lying down it can be assumed that some permanent pathological change has taken place in adjacent organs, such as cholecystitis in the gall bladder, colitis in the colon, and chronic intestinal disturbance in the small bowel, or that, in the reclining posture, either traction or pressure is exerted on them by the enlarged liver.

Brown (Osler's "System") describes the pain of hepatoptosis either as spontaneous, or as being brought on by jumping, walking, raising the right arm, sneezing, coughing, and yawning, while sometimes paroxysms of pain occur without apparent cause. The pain is usually relieved by having the patient lie on the back or on the right side, or by manual replacement of the organ. The pain is commonest in the right hypochondriac and epigastric regions, radiating thence toward the right shoulder or to the flank. Pressure, though rarely painful, often produces peculiar sensations in various portions of the body, especially in the right arm and shoulder.

Adhesions. Following perihepatitis, and a result of it, adhesions take place between the liver and the adjacent structures. Adhesions between the liver and its associated structures, gall bladder and bile ducts, may be present without the production of pain, though pain is likely to occur when the patient changes his position, or during some phase of digestion. Should the pain become prominent on change of position, the area in which it is felt is a good indication of the location of the adhesions, provided they lie between the liver and the parietal peritoneum. Should adhesions not be present in this location, but between the liver and some intraabdominal organs, the pain, or rather discomfort, will be referred to the area to which this organ refers its discomfort and distress. Should adhesions, for instance, be present between the liver and the stomach or intestine, the reference will be to the somatic area associated with the stomach and intestine, and not to the area associated with the liver. In cases in which dense adhesions exist between the stomach and the gall bladder the pain may be in the epigastrium or over the ensiform cartilage. It is somewhat acute and is more or less severe, especially on movement. Should the pain be especially prominent at the time of gastric digestion it is reasonable to assume that the adhesions involve the stomach. Should it occur at the time of the colonic passage of food it is most probable that the colon is the adhering organ. In all cases of adhesive formations there is a history of previous acute pain, the result of infection of the liver, gall bladder, ducts, or adjacent viscera, with a gradually developing chronic (adhesive) pain.

Universal chronic serositis, a disease in which all the serous membranes are involved, is generally free from hepatic pain and is slow in its development. Its principal symptom is ascites.

ESSENTIAL DISEASES OF THE LIVER.—Pain is absent in amyloid enlargement, fatty liver, leukemic enlargement, adenoma, cysts (simple), angioma and fibroma. Pain is present in the cirrhoses, hepatitis, acute yellow atrophy, syphilis and new growths, hydatid, etc.

In chronic atrophic cirrhosis the pain is dull and heavy in the first stage. There is also present tenderness due to intermittent attacks of perihepatitis. In hepatitis the pain is over the liver and is propagated to the area between the clavicle and the acromion process of the scapula on the front of the chest. The liver is very tender on pressure. In portal cirrhosis pain is absent in the last stages. In the early stages there is a dull, heavy pain. Tenderness in the right side (hypochondrium), intermittent in character, is also present. In biliary cirrhosis there are periodic attacks of pain with fever and jaundice. Tenderness is found over the liver and spleen.

In acute yellow atrophy pain is nearly always present and is often spontaneous. Tenderness is so marked that it can be elicited when the patient is unconscious. In syphilis there is no pain, unless the growth is tertiary and a perihepatitis has resulted with inflammation of the capsule; in this condition pain is common. In lymphadenoma pain is absent. In hydatid cystic disease the only discomfort may be a feeling of weight or of dragging in the abdomen. If the peritoneal covering of the liver is inflamed pain is present on respiration. Tenderness is also a marked symptom. In fatty liver there is no pain. The enlargement is slow and the liver surface is smooth. Lardaceous disease is generally secondary to other conditions. The enlargement is constant, slow, and painless. Simple cysts of liver are rarely large enough to cause any special disturbance. In adenoma, angioma, myxoma, fibroma, and lipoma there is no pain.

GALL BLADDER

General Etiology.—The pain of gall-bladder disease is due to over-distention of the walls, excessive contraction of its muscular coat, or irritation of the mural nerves from either of the above, or from inflammatory processes, which may be intra- or extramural. Intramural inflammation affects only the mucosa and musculature, while extramural inflammation affects the peritoneum. The dragging by adhesions also produces pain.

Over-distention of the gall bladder is the cause of pain in such disorders as hydrops of the gall bladder, but only when the condition is acute. It is most likely that over-distention of the gall bladder does not of itself cause pain, unless there is an obstruction to the onward flow of bile, such as may be produced by either a stone in or an inflammation of the cystic or common duct. The obstruction hinders the flow of the bile and the musculature of the gall bladder, attempting to force it on, is thrown into a series of painful spasms.

In gall-bladder colic the pain is generally sudden in its onset and persists for some time, when it either gradually fades away, or, owing to the passage of the stone or the removal of the duct obstruction, it disappears, sometimes quite suddenly. In either case it leaves a legacy of tenderness over the site of the lesion.

Over-distention of the gall bladder may occur from obstruction of the cystic or common duct by (a) inflammation, (b) stone, (c) pancreatic lesions, (d) pressure from adjacent viscera, (e) tumors, or (f) excessive contraction of the muscular coat. The gall bladder is similar to many other abdominal viscera in the method of its pain production. This pain is of a colicky character, and, at the time of its production, palpation in the gall bladder region will reveal a hard tumor mass, due to a spasmodic muscular contraction of the gall bladder. Should this spasmodic muscular contraction be relieved, either because of the opening of the gall duct passages or of exhaustion of the musculature, the pain will be eased and the hard tumor mass will disappear. If the bladder is not emptied the mass persists, but soon loses its hard consistency.

One of the commonest lesions of the gall bladder is inflammation. In addition to the local pains (the result of local peritonitis), inflammation of the gall bladder causes well-marked referred pains. The inflammation is generally of a very active type and is very violent. It produces a well-marked tenderness. If this tenderness suddenly becomes general and is associated with signs of a spreading peritonitis, perforation of the gall bladder should at least be thought of and searched for. Inflammation of the gall bladder (cholecystitis) is invariably due to infection.

The common causes of gall-bladder infection, probably in the order of their frequency, are colon bacillus, typhoid bacillus, and influenza bacillus. The pneumococcus and tubercle bacilli are only rarely found as causative agents. Pregnancy seems especially to be a predisposing factor for gall-bladder infection. Diarrhea is a prominent symptom of infection of the bile passages. It occurs after eating or, in some cases, in the middle of a meal. At the time of the diarrhea severe pain is felt in the epigastrium. This pain is probably synchronous with, and due to, the contraction of and the emptying of the gall bladder.

Following the inflammation adhesions form, but these, unless they are attached to the anterior abdominal wall, are not particularly painful. Should they be so attached breathing becomes very painful, and the pain is of a dragging character. Should adhesions exist between the gall bladder and the stomach or duodenum, the pains are associated with digestive activity. In these cases there is some history of a previous acute attack, in which the pain was confined to the gall-bladder region.

Diagnosis.—The means of eliciting gall-bladder pain are palpation and percussion. Tenderness on palpation is generally most pronounced beneath the costal margin at the level of the ninth or tenth costal cartilage. There is here present a point of most exquisite tenderness, and around this an area which is not quite so tender. In some cases, where there is an associated appendix involvement, the hyperesthesia extends down to the neighborhood of the appendix, over which there is another point of maximum tenderness.

In lesions of the gall bladder, if pressure or percussion is applied over any portion of the abdomen, the pain is felt in the

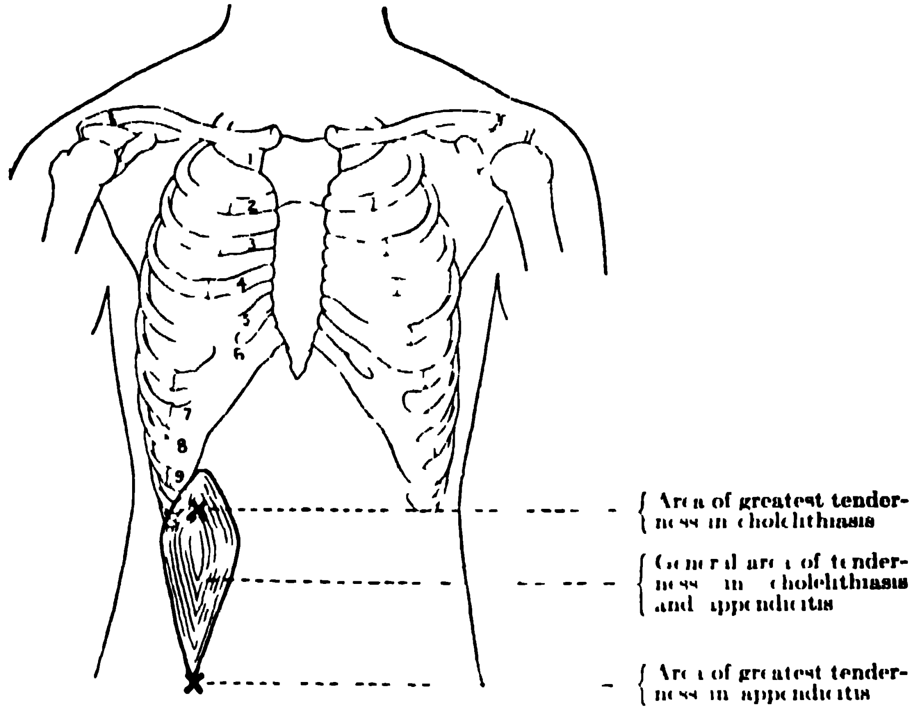
1
2
1
4
5
6
7
8
9
Area of greatest tenderness in cholelithiasis
General area of tenderness in cholelithiasis and appendicitis
Area of greatest tenderness in appendicitis

FIG. 126. AREA OF GREATEST TENDERNESS IN DISEASES OF THE GALL BLADDER AND APPENDIX.

The upper X indicates the point of maximum tenderness in gall-bladder inflammation, the lower X that of the appendix. In both, though the entire area indicated may be tender, the points of maximum tenderness will differentiate the two disorders.

gall-bladder area or region. This is one method of differentiating gall-bladder disease from appendicitis.

For the purpose of differentiating gall bladder (direct) tenderness from that due to lesions of other organs, Murphy elaborated a special technique. His method of eliciting the tender points in gall-bladder disease is as follows: Having previously removed all clothing from the part to be examined or from its neighborhood, place the patient in a sitting position, bent well forward, with his hands resting upon his knees. The examiner now stands behind the patient and places his hand, with the palm flatly against the abdomen, immediately below the ribs on the right side. Have the patient take deep breaths. After each expiration the examiner's hand follows the abdominal wall until it approaches closely to the affected gall bladder and adjacent tissues, when suddenly the respiration ceases with a gasp and the patient complains of severe pain. This indicates that the hand has come into contact with the inflamed tissues. Naunyn's sign as given by Da Costa is very similar.

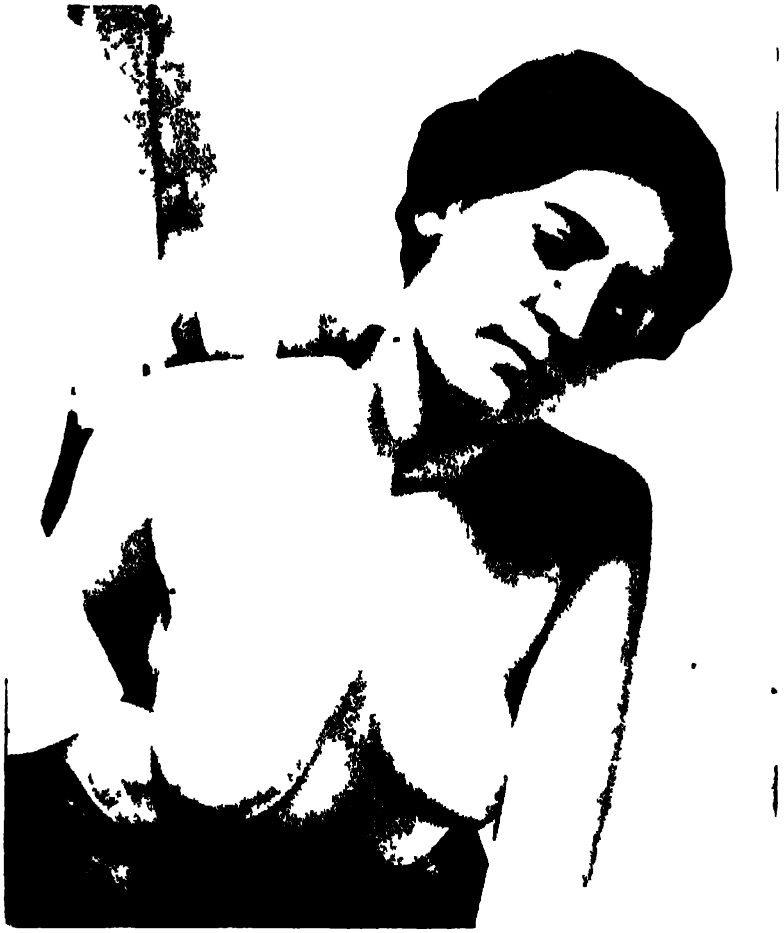

FIG. 127.—METHOD OF ELICITING GALL-BLADDER TENDERNESS.

Tenderness at Mayo Robson's point is also supposed to indicate inflammation of the gall bladder or ducts. This tenderness lies along a line extending from the tip of the ninth costal cartilage to the umbilicus. The point of greatest tenderness is known as Robson's point, and is situated one inch to the right of the umbilicus.

Percussion as a means of eliciting pain has been discussed under the general consideration of liver pains.

Radiation of Pain.—In gall-bladder disease the patient frequently complains of pain, which, according to Schmidt, may extend to the right nipple and backward into the shoulder blade, and thence into the lumbar region. This radiation is more frequent in the presence of an associated perihepatitis. Associated pains in the lower extremities may be the result either of a neuralgia or a septic thrombus (iliac or femoral). Pains in the left arm may be symptomatic of a true angina pectoris, induced by the high blood pressure caused by the vesicular pain. Schmidt also claims that radiation of pain into the genitals with retention of urine may occur. Such a condition, however, is rare and, when it does occur, is generally due to peritonitis. That such pain ever occurs without some associated complication or some concomitant disease is doubtful.

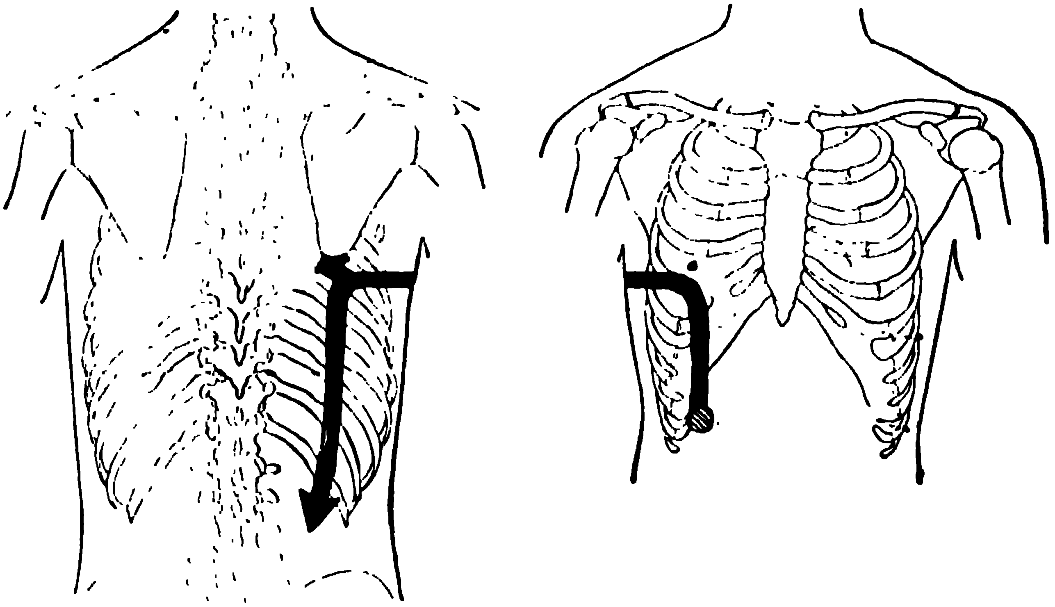

FIG. 128.—RADIATION OF GALL-BLADDER PAIN AS GIVEN BY SCHMIDT (p. 210).

Radiation into the right iliac fossa sometimes occurs, and it is very apt to lead to a diagnosis of appendicitis. In fact, in many of these cases, an appendix inflammation is associated with the gall-bladder disease.

Pain referred to a distance is seldom found in diseases of the gall bladder except in neurasthenic patients. In the neurasthenic all manner of pains are complained of, in addition to the original pains of the gall-bladder inflammation. An example of this was had in the case of a patient who complained of pain over the spine, in the right leg, and the back of the head. At the same time there were tenderness and pain in the epigastrium and around the umbilicus.

The location, direction and radiation of pain produced by pressure will frequently help to differentiate gall-bladder pains from those due to disease of the kidney, duodenum, or stomach. If the gall bladder is inflamed, pressure over it will cause pain to appear in the right shoulder and in the epigastrium, to the right of the median line, while, in the other diseases mentioned above, the pain will appear in their respective associated areas.

It is sometimes difficult to distinguish the tenderness due to disease of the gall bladder from that due to disease of the appendix. An aid to diagnosis is that in disease of the gall bladder the segment of the rectus muscle over the gall bladder is in a state of contraction, while the segment over the appendix may be flaccid. Another point of differentiation is that in gall-bladder involvement the maximum point of tenderness is at the junction of the ninth or tenth costal cartilages with the costal arch, while in appendicitis the area of greatest tenderness is at a point about midway on the line joining the umbilicus to the anterior superior spine of the ilium.

Reflex Tenderness.—It is claimed by Schmidt that in gall-bladder disease there is a "point of sensitiveness along the upper portion of the trapezius muscle about three fingers' breadth distant from the acromion. Pressure at this point causes pain which radiates to the gall bladder; and, vice versa, pressure over the gall bladder causes pain that radiates to this area." He likewise claims that these conditions are found in liver abscess and in subphrenic inflammations. They seem only to be associated with diseased processes in which the diaphragm is involved. The vertebræ between the fourth and twelfth thoracic may be tender on pressure.

Diseases Causing Pain.—*Gall-bladder colic* is a term given to the pain produced by an over distention of the gall bladder from any cause. But, as long as drainage from the gall bladder is free, viz., as long as the cystic and common ducts are free, there will be no pain. However, should the cystic or the common ducts become occluded, pain immediately ensues. Since the causes of the blocking of these ducts will at the same time be the causes of gall bladder pain, it behooves us to study them well. The common causes of blocking of the ducts may be arranged in three groups, namely: (1) intramural, in which the obstruction is due to a foreign body, such as a gall stone or an ascaris; (2) intramural, such as inflammation and new growths, the inflammation causing the stenosis may occur at any point along the course of the bile pathways, may be local to the ducts, or may be an extension of any inflammation from the duodenum, ascending through the papilla of Vater into the biliary system, or the inflammation may be confined to the ducts, new growths arising *de novo* in the walls of the bile passages are extremely rare; (3) extramural, such as kinks, adhesions, pressure from adjacent organs or tumors. Any of these, by temporarily shutting off the exit of bile, may be the cause of temporary distention, and give rise to colic.

In some cases gall stones may be present without causing colic; but this happens only when the gall stones have been present for some time and the gall bladder and ducts have accommodated themselves to their presence. The presence of stones in the gall bladder, in the absence of pain, is very common in enteroptosis, in which case the patient may complain only of dyspeptic symptoms and some soreness in the epigastrium.

When gall bladder colic occurs it resembles other colics in that there is a period of distress followed by a period of freedom, and this in turn is followed by pain which gradually increases to the maximum, then gradually decreases until the patient is again free from pain (intermission). Again, the pain commences, and at first is of slight intensity and then gradually increases to the maximum and gradually decreases to the minimum. (See Varieties of Pain, Colic.) In many cases gall stones cause small abrasions on the vesicular mucous membrane, and these permit the entrance of bacteria, which give rise to inflammation, so that the pain of colic is frequently associated with the pain of cholecystitis (q. v.).

In some cases intestinal colic has been mistaken for biliary colic. However, biliary colic can be diagnosed by the tendency of the pain of intestinal colic to migrate and to localize itself in different segments of the abdomen, depending upon the location of the muscular spasm in the intestine.

Cholecystitis. The pain of cholecystitis is of two types: (a) paroxysmal and (b) constant.

The paroxysmal pain is most likely to be associated with the occasional passage of a gall stone. When present it indicates that the duct is intermittently blocked. This blocking may be due either to a stone or to swelling of the mucous membrane. Should the duct become permanently closed, the pain becomes constant, owing to the continual effort of the gall bladder to empty itself.

Constant pain is also an indication that the inflammation which is present has spread to the peritoneal coat and has induced a peritonitis. When the inflammation has been active for some time the accumulation of biliary secretion in the gall bladder may, if the duct becomes occluded, cause a distention of that organ and thus produce pain. However, this obstruction must be in the cystic duct, and must also be sudden in onset. Otherwise, the gall bladder accommodates itself to the distention without pain production.

In every case when the duct is occluded, in addition to pain and tenderness, a tumor mass is formed. The size of this mass varies and seems in some instances to depend upon the alternate distention and emptying of the gall bladder. The common cause of such a state is a gall stone having a ball-valve action, or a kink, which can be straightened by the pressure of the bile posterior to it. In both cases the passage of the bile is followed by the relief of the pain, which reappears on the reformation of the tumor.

This tumor, which is formed by the distended gall bladder, is freely movable from side to side, and follows the inspiratory movements of the liver. Temperature elevation and increase of pulse rate accompany this condition. Jaundice seldom occurs. Clay-colored stools may be present, and nausea and vomiting are frequent. A symptom group of this description indicates a recurring cholelithiasis, from which a cholecystitis has arisen. When the tenderness suddenly increases, becomes more acute, and is associated with vomiting, it most commonly indicates the beginning of a local peritonitis.

If the primary pain, which may have been either constant or intermittent, suddenly becomes most severe, with increasing tenderness, or if the tenderness shows a tendency to spread, and if, at the same time, there is an increasing rigidity of the upper abdomen, a diagnosis of gall-bladder perforation is justifiable.

Deaver, in speaking of cholecystitis, says that the "pain is situated in the epigastric region, is usually sharp, appears suddenly or gradually, and is increased by motion of the entire body or of a regional organ, such as may be made by the stomach, in peristalsis or in vomiting." He further states that in the absence of peritonitis "the accompanying tenderness indicates the situation of the gall bladder, and the presence and extent of peritoneal irritation or of peritonitis are indicated by the extent of the associated tenderness."

The pain and tenderness of cholecystitis are generally associated with rigidity of the abdominal muscles. There is a rigidity of the rectus abdominis on the right side, localized to the diseased area; and, as the disease advances, this rigidity increases *pari passu* with it. Finally, if a generalized peritonitis results, all of the abdominal muscles become contracted.

In all inflammatory lesions of the gall bladder deep breathing is painful. Pain also results if the inflamed and sensitive peritoneum of the gall bladder is pressed against adjacent structures. as the stomach, the colon, and the anterior abdominal wall. Movement of any kind (walking, running, or even bending over so that the intraabdominal contents are on the stretch) causes

Should the inflammation have spread to the adjacent liver tissue a friction rub can be heard on auscultation, and sometimes can even be felt on palpation.

Cholecystitis may be mistaken for a movable kidney; but the elevation of temperature, the increased leukocyte count, pain in the prone position, and the location of the local tenderness and its radiation, in cholecystitis should differentiate this from the movable kidney. However, in many cases of cholecystitis pain may be entirely absent. That this is not by any means uncommon can be deduced from the evidence furnished at autopsy, where old and chronic inflammations of the gall bladder are found, with an absolutely negative history of a gall-bladder infection. If the gall bladder is in close relation to the appendix, inflammation of it may induce an infection of the adjacent appendix, and so cause appendicitis. This can happen only in very severe cases of cholecystitis when the peritoneum is diseased, and only so, if this, in continuity or contiguity, affects the serous coat of the appendix. This secondary appendicitis may so divert the attention as to cause us to overlook the serious gall-bladder involvement.

New Growths.—The new growths of the gall bladder may be classed as malignant and benign.

Malignant growths, of which carcinoma and sarcoma are the chief, if not the only, representatives, are generally the cause of at least some pain and discomfort. At first the sensation is more like an unrest or a vague distress referred to the area of distribution of the seventh or eighth dorsal segments, which, according to Head, are most commonly affected, though other segments, as the fifth and sixth, are also very likely to be involved. By means of this referred sensation, which later may increase to actual pain, it is very difficult to differentiate gall-bladder from liver disease, as the relationship between the two is so intimate that diseases affecting the gall bladder generally at the same time produce reflex disturbances in the liver; hence it is next to impossible for a lesion of the gall bladder to be present without producing some associated disorder in the liver. Should well-marked pain be felt, localized to the region of the gall bladder (see figure), and a tumor mass, tender on pressure, be detected, together with cachexia and emaciation, it is a fairly good indication that malignant disease of the gall bladder is present. New growths, however, do not always give rise to pain, for, in many cases, the growths are latent and produce no complaints until the tumor cells begin to invade the adjoining structures. When this occurs the symptoms of the gall bladder involvement, which may have been so vague and indefinite that they previously were unnoted, become of diagnostic value.

Non malignant growths of the gall bladder are generally painless. Under non malignant growths are included hydatid cyst, papilloma, adenoma, fibroma, and fatty cysts.

New growths of the gall bladder are sometimes confused with tumors of the hepatic flexure of the colon; but these latter can generally be differentiated by the presence of signs of intestinal obstruction. The range of motion and the arc of rotation in tumors of the colon is different than in tumors of the gall bladder; however, owing to adhesions, which may coexist with the two growths, it is often very difficult to make a positive diagnosis.

Hysteria often produces a set of symptoms that resemble gall-bladder colic. Here it is extremely hard to make a diagnosis, but perhaps if we remember that in nearly all cases of hysteria there is some basis for the pain phenomena, the diagnosis will be far easier. In ninety nine cases out of a hundred a diagnosis of hysteria will be found to be incorrect.

GALL-DUCT PAIN

Etiology.—Gall-duct pain is due to two causes: (a) obstruction of the ducts, and (b) inflammation of the ducts, with extension of the inflammation to the adjacent peritoneum.

Obstruction of the ducts invariably leads to gall-duct colic, and, if the obstruction persists, may end in gall-duct inflammation (cholangitis). The latter inflammation may spread through the wall and involve the peritoneum. The pain of peritonitis is now added to that of the original complaint. The causes of obstruction of the gall ducts are: intramural, by foreign bodies (such as gall stones, ascarides, etc.); intermural, as inflammation (cholangitis) and new growths; and extramural, by new growths, kinks, and adhesions.

Pains that have their origin in the ducts may be classified as: (a) gall-duct colics from gall stones, ascarides, and new growths; (b) inflammation pains (cholangitis), having their origin from spread of inflammation from the duodenum; (c) inflammation from infection with bacteria eliminated by the liver; (d) inflammation due to infection following the lodgment of gall stones; and (e) malignancy.

Location of Pain.– The pain of gall-duct colic is sudden in its onset and is located in the epigastric region. In some cases the pain due to obstruction of the common duct may be referred to the anterior surface of the chest at about the fourth to the sixth left costal cartilages. Pain from obstruction of the cystic duct may be referred to the right of the vertebral column, between the eighth and eleventh dorsal vertebræ, while hepatic duct pain may be referred to the right hypochondrium, to the thigh, and even to the head and neck. In some cases, owing to the location of the pain in the cardiac region, gall-duct colic has been mistaken for angina pectoris (Hall). In other cases it may begin in the epigastrium and radiate over the abdomen to the right subscapular region and has even been felt in the right lumbar region (Maylard). It has also been known to radiate into the left shoulder. When the pain in its onset is constantly located on the left side, adhesions to the stomach are generally found.

Character of the Pain.— Gall-duct colic due to stone is generally very sudden in onset. Sometimes it follows the ingestion of food, particularly acid drinks or alcoholic beverages, though the attacks may occur independently of the taking of food. It is very prone to occur at night, four to six hours after the ingestion of the last meal. The colic occurs in paroxysms, following each other at variable intervals, at first of great severity and then of gradually diminishing intensity. Between the paroxysms there is, in the gall-bladder region, a constant dull aching which at times becomes magnified into pain of great severity. The cessation of the paroxysms generally indicates the passage of the stone either from the cystic to the common duct or from the common duct into the duodenum; or it may be that, owing to the ball-valve action which is present, the stone has been forced back to the dilated part of the duct or to the gall bladder. The first attack of biliary colic is the most severe, because at this time the duct has not as yet been dilated. During successive attacks it becomes of large caliber, the stone passes through more easily, and the individual attacks, therefore, are of less severity. An attack generally lasts one or two hours and ends with nausea and vomiting. The nausea and vomiting seem to relax the duct and permit the more easy passage of the stone.[1]

After the painful paroxysms there is frequently present in the upper part of the abdomen a dull aching which persists until the next attack occurs. In some cases the pain becomes more severe, loses its spasmodic character, and gradually spreads over the upper abdomen. At the same time, epigastric tenderness is marked and abdominal distention occurs. Here we are dealing with an associated peritonitis.

Biliary colics often come on without any apparent active exciting cause, though, as stated above, they are often associated with the ingestion of food or drink. They often commence after a severe spell of vomiting, the result of gastritis following an indiscretion in diet. At first, on the entrance of the stone into the duct, the pain is of a dull character; and then, owing to the movement of the diaphragm and of the abdominal wall, the gall stone or stones are forced deeper into the cystic or common duct and a typical gall-stone colic results. The pain and vomiting of the gastritis now merge into the pain and vomiting of the colic. This seems to be the history of nearly all gall-stone cases. The stones remaining quiescent in the gall bladder for a number of years, until suddenly, owing to forcible movements and changed relationship of the viscera in the abdominal cavity, they are displaced into the cystic duct, where they may lodge and cause the paroxysmal, cutting pain which is so distressing. Below is a citation of a case illustrating how this occurs:

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[1] On the passage of the stone into the duodenum, there is, according to Keay, a peculiar gliding sensation to the right of the tenth and twelfth dorsal vertebræ (Rolleston, p. 725).

In this patient the right ovary was removed, owing to its cystic state. The history, as given by the patient, was that a month after recovery from typhoid fever she was taken with a violent colic, the pain, extremely severe, being present in the epigastrium. It seemed to lie in the mid-line, a short distance above the umbilicus. Vomiting was severe at this time and was followed by diarrhea. These conditions quickly improved and the patient was in fairly good health with the exception of a pain in the back, the continuity of which (the pain) was interrupted by paroxysms of increased intensity. Three weeks after this first attack she was again indiscreet in her diet and another attack of acute indigestion followed. Vomiting occurred, all of the stomach contents were expelled, and, though the stomach was washed out, nausea and retching still continued. The pain also was different. Instead of being in the median line and slightly above the umbilicus, it was more to the right and immediately below the costal arch. It seemed to run directly through to the back. It was extremely severe, and was described by the patient as being sharp and breaking in character. It was at first almost continuous, but finally became slightly intermittent. Localized tenderness was present over the gall-bladder region. Operation revealed a stone occluding the cystic duct.

It is evident that gall-stone colic may be caused by the lodgment of calculi in either the cystic, hepatic, or common ducts. The stone or stones deposited in the cystic duct are generally of large size and the colic does not disappear until either the stone is passed, which is rare, or until it is returned into the gall bladder, which is more common. Before this takes place gall-bladder colic occurs as a complication. The same holds true in the common duct; but in common-duct colic jaundice comes on as a complication, while in cystic-duct colic it is absent. Hepatic-duct stones are usually small and resemble gravel very closely, so that the pain is not so acute as in the other colics. Examination of the feces will often disclose the small calculi. X-ray examination may determine at once the presence and position of the calculi. However, in the vast majority of cases the X-ray is of little value.

More or less cholecystitis always accompanies all gall stones. In fact, it is the inflammatory process which is responsible for the passage of the calculus out of the gall bladder, so that frequently the gall-duct colic follows a cholecystitis (Rolleston). In some cases a gall stone becomes impacted in the cystic or common duct and pain may be present, intermittently, for weeks. These attacks are often associated with slight temperature, chills, and an increase of pulse rate, the so called Charcot's intermittent fever. The patient is generally very restless and throws himself into all sorts of positions. Tenderness in the region of the gall bladder, according to Bishop, is invariably present, and not only is found during an attack, but persists afterward, and can always be elicited by properly applied pressure.

Associated Symptoms.– Symptoms associated with gall-duct colic are (a) vomiting, which at times is most severe, the vomitus containing no bile, which likewise is characteristic of the stools, which are light in color and of a very disagreeable odor; (b) bilirubin is present in the urine and it leaves yellow marks upon the linen; (c) jaundice is also present, but this is not absolutely characteristic of gall-duct colic, as it is also sometimes present in gastritis and appendicitis, in duodenal ulcer, and in carcinoma of the hepatic flexure; (d) temperature elevation is usual and persists for some time after the cessation of the attacks. The rise of temperature is generally an indication of the presence of a localized peritonitis. Constipation most frequently accompanies gall-duct colic; when diarrhea is present it is a probable sign that intestinal complications have ensued. As a result of the pain of gall-stone colic, syncope and even death have been known to occur.[1]

Differential Diagnosis.—Gall-stone colic should be diagnosed from (a) gastric ulcer, (b) floating kidney, (c) renal colic, (d) appendicitis, (e) mucous colitis, (f) hepatic crises of tabes, lead colic, angina pectoris, gastric ulcer, malignant diseases of the gall ducts, pancreatitis, and lumbago. For the most important of these differential diagnostic signs see Differential Diagnosis of Diseases of the Liver.

In *catarrhal cholangitis*, pain, as a rule, is absent; likewise there is no tenderness. This difference between this form of jaundice and infective and calculus jaundice should be noted. Should biliary colic supervene during the course of a simple catarrhal jaundice it is an indication that the gall bladder has become infective and cholecystitis has supervened.

Suppurative Cholangitis.—In this disorder pain may be entirely absent. When present it may be due to an extension of the inflammation to the peritoneum, causing peritonitis. This extension occurs directly through the wall of the ducts or extends through the liver tissue from the inflammation located at the terminal openings of the ducts in the liver. Obstruction of the bile ducts may occur from some of the factors which were the original causes of the inflammation, such as gall stones, worms (ascarides) in the ducts, and rupture of hydatids into the ducts. Malignant disease may also cause obstruction and produce inflammation and jaundice. When the bile ducts are obstructed the same symptom-complex is present as is found in duct obstruction from any other cause. Should ascarides be the cause, either the worms or the ova may be found in the stools.

Cancer of the biliary passages is generally first announced by icterus; then, as the lesion progressively increases in size, infiltration into the surrounding ligaments takes place, and a pull may occur on the peritoneum, and so cause pain. This pain, though generally secondary to the jaundice, may be primary and is of a dull, aching character. It is nearly always present and is found in the right hypochondrium, in some cases in the left epigastrium. When it is located on the left side, the adjacent structures, as the pancreas (head) or the pyloric end of the stomach or duodenum, are involved. Biliary colic is sometimes present and may be due to the presence of vesical gall stones. In other cases no gall stones are found and the colic is due to muscular spasms in the walls of the duct from irritation by the malignant growth. However, carcinoma of the gall ducts is at times entirely without pain. This occurs when the obstruction is not of enough magnitude entirely to block the ducts. Symptoms indicative of malignant growths of the gall ducts are distention of the gall bladder, the presence of a tumor in the epigastrium, emaciation, and

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[1] Rolleston, "Diseases of the Liver, Gall Bladder and Gall Ducts," p. 725, quoted from Allbutt in "System of Medicine," Vol. III., p. 47.

DIFFERENTIAL DIAGNOSIS, GALL-BLADDER COLIC AND GALL-DUCT COLIC

SYMPTOMS	GALL-BLADDER COLIC	GALL-DUCT COLIC
Pain.	More severe than in gall-duct colic. Not so frequently associated with digestion is is the pain of gall-duct colic. Referred to right shoulder or to the back between and below the scapula.	Less severe. Frequently associated with the ingestion of food. Referred to the left side of the chest about the line of the third or fourth costal cartilage.
Jaundice.	Generally absent. This is especially true should the cause of the gall-bladder colic be an obstruction in the cystic duct.	Generally present, always so if the obstruction is in the common or the hepatic ducts.
Local Tenderness	Higher in the epigastrium and more toward the costal arch than is the tenderness associated with gall-duct colic.	At Mayo Robson's point.
Vomiting	Common and continued after the first paroxysm. Generally no bile.	Generally present at first. No bile.
Tumor.	Always present, is movable if adhesions are not present.	No tumor present.

Gall-bladder and gall-duct colic are often so intimately associated that it is very difficult to distinguish between the two. The gall-bladder colic is almost an invariable accompaniment and sequela of gall-duct colic.

[illegible]. Jaundice, which gradually becomes more intense until it is dark green or almost black in color, is also present.

The stools are free from bile pigments, though bile is found in the urine. Secondary metastatic growths may also occur, and when found make certain the diagnosis of malignancy.

The pain due to *cancer of the pancreas* is different from that due to cancer of the bile ducts, in that it is located in the epigastrium, while the latter is in the hypogastrium. However, the two conditions are very hard to diagnosticate from each other.

Gall-stone colic differs from obstruction colic due to cancer by the onset of the colic before the appearance of the jaundice. Courvoisier's law should also help in the diagnosis; namely, that in calculus obstruction of the common duct the gall bladder is not enlarged, while in obstruction due to malignant disease of the common duct it forms a well-defined tumor.

CHAPTER XXVII

THE PANCREAS

GENERAL CONSIDERATIONS

It is only recently that recognition of the diseases of the pancreas has emerged from the deep obscurity heretofore existent. In the last decade or two that organ has been studied, its diseases and disorders defined, and their symptoms arranged and classified. Even to-day, however, the pathological processes are still a matter of considerable conjecture and autopsy often discloses disease which the clinician has been unable to define. But as the years go on the pathology and the symptomatology are gradually being more and more correlated, until to-day we have much more definite knowledge and exact means for diagnosing pancreatic lesions.

Symptoms which may be present in any disease are only of as much value as we are able to interpret them in the terms of that disease, and this is especially true of pancreatic pain, for it is probably more difficult in many cases of pancreatic disorder to determine the full value and significance of pain than it is to interpret any other of the pancreatic symptoms. So much reliance has to be placed upon the word of the patient, and so much dependence upon the accuracy of his interpretation, that it is very difficult to measure the full extent of the disorder from which he suffers. To understand thoroughly the pains due to disease of the pancreas and the method of their production and radiation it is necessary to consider: (1) the nerve supply of the pancreas; (2) its structure; (3) its peritoneal relations; and (4) its relationship to other parts.

Nerve Supply.—The nerve stimuli to and from the pancreas travel through both cerebrospinal and sympathetic fibers. The cerebrospinal filaments are the vagi; the left vagus being brought into contact with the pancreas through the hepatic and splenic plexi, while the right communicates with the hepatic plexus, which, through the pancreatico-duodenal plexus, supplies the right half of the pancreas. These fibers probably convey vasomotor and secretory impulses, though it is very probable that both vagal and sympathetic fibers carry painful stimuli, although it has been held that it is mainly through the splanchnics that painful stimuli are carried, and it is in the distribution area of the nerves, whose centers have a common relationship with the centers for the splanchnics, that pain is felt. The splanchnics arise from the sixth or possibly fifth thoracic sympathetic ganglia to the twelfth thoracic ganglia. These ganglia, in turn, are connected with the corresponding segments of the cord to which the stimulus is carried, and from thence reflex sensations are referred back to the abdominal wall. The distribution area of these nerves extends from about the level of the nipple to the crest of the ilium. That the pain is, in most cases, referred to this entire area cannot be admitted, because nearly all the cases of well-defined pancreatic lesions which have been carefully studied do not show such wide

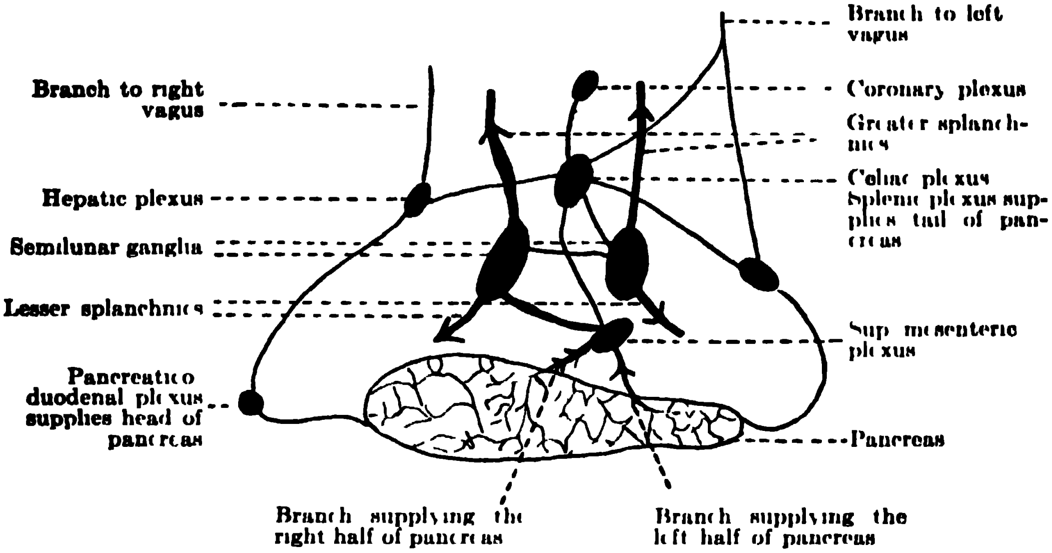
Branch to left vagus
Branch to right vagus
Coronary plexus
Greater splanchnics
Celiac plexus
Splenic plexus supplies tail of pancreas
Hepatic plexus
Semilunar ganglia
Lesser splanchnics
Sup. mesenteric plexus
Pancreatico duodenal plexus supplies head of pancreas
Pancreas
Branch supplying the right half of pancreas
Branch supplying the left half of pancreas

FIG. 129.—NERVE SUPPLY TO PANCREAS.

distribution. From the clinical findings, it seems that possibly the greater splanchnic, alone, conveys the pain-producing stimuli; for it is in the distribution areas of the nerves arising from the same segment of the cord, to which the greater splanchnic is connected, that pain is felt. According to Robson and Cammidge, the nerves accompany the arteries to the gland, in the substance of which they travel alongside the ducts, and terminate around the acini in a rich plexus of nerves which send fibers to the secreting cells.

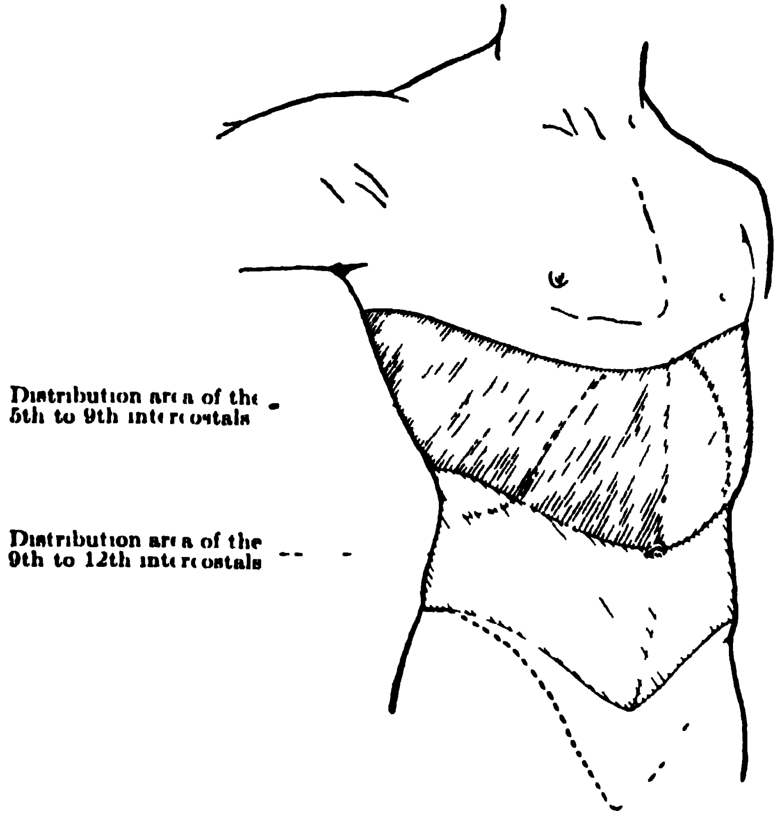
Distribution area of the 5th to 9th intercostals
Distribution area of the 9th to 12th intercostals

FIG 130.—DISTRIBUTION AREAS FOR PAIN DUE TO PANCREATIC LESIONS.

Thus far a study of the hyperesthetic or hyperalgesic areas, by Head's methods, in pancreatic affections has not been made. The presence or absence of these zones might be of considerable diagnostic merit should they be studied carefully enough to make them of value. Figure 130 only indicates in a general way the distribution areas for pain due to pancreatic lesions.

Structure of the Pancreas.—The structure of the pancreas does not offer any special facilities for pain production besides those which are found in ordinary secreting glands. All glands have one or more ducts, and it is the ducts which generally are the cause of the pain phenomena. Inflammation occurs in the ducts, producing a stenosis, with blocking of the secretion, and this leads to inflammation in the gland and muscular spasm in the duct. The duct may also be obstructed by a calculus, or by a foreign body, such as an ascaris.

Peritoneal Covering — Stretching of the peritoneal envelope of the gland cannot be blamed for pain production, for the very good reason that an envelope in the form of a capsule is missing. Posterior to the gland there is no peritoneum [1] and the gland

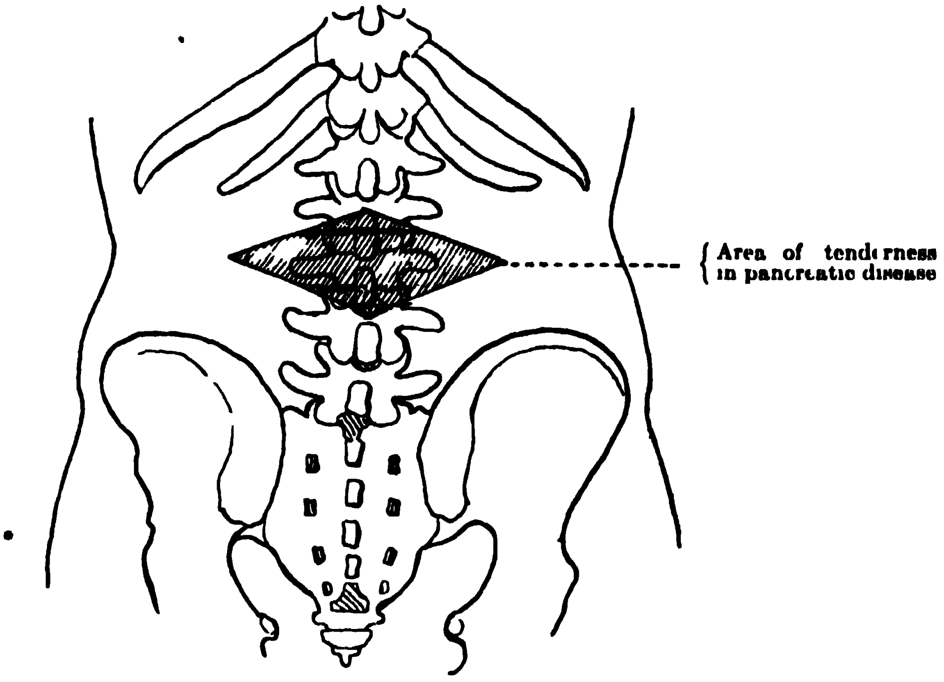

FIG 131 —RELATION OF PANCREAS TO POSTERIOR ABDOMINAL WALL
It is only immediately over the vertebræ that the pancreas comes into close relationship with the wall, the other portions being separated from it partly by the duodenum and partly by the kidneys. Therefore pressure made between the second and third lumbar vertebræ will cause pain when the pancreas is inflamed

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[1] This is disputed by the Viennese schools. It is quite true, as stated by them, that in the embryonic development the gland is covered by peritoneum, but English and American anatomists claim that during development this covering is absorbed and that the gland finally lies in direct contact with the posterior abdominal wall.

parenchyma comes into direct contact with the connective tissue on the posterior abdominal wall, so that inflammation of the gland itself quickly spreads to the posterior wall and causes a local pain in that region. This pain is most prominent, though it is more of an aching than a pain, and, as is usual where the deeper structures of any part are affected, tenderness on deep pressure over the area of the gland is present.

Relationship to the Other Parts. – The pancreas lies in intimate relationship with many important structures. It is almost entirely surrounded by the duodenum; on either side, it is in contact with a kidney, while above it lies the stomach. The common bile duct passes through its parenchyma, and beneath its lower margin pass the superior mesenteric vessels and nerves. Consequently any lesion, even the simplest, will cause a reaction out of all proportion to its extent, so that in the diagnosis of diseases of the pancreas our surveys must never be warped by the signs due to associated lesions in other organs.

One of the most confusing, while perhaps the most important, of these symptoms is pain. Pain is almost always present in all diseases of the pancreas, though it may not be found until late in the process; and while it is almost invariably present, it likewise is almost constantly modified by the lesions produced in adjacent organs. The most commonly associated pain is that due to stenosis, or obstruction of either the pylorus, the duodenum, or the common bile duct. If gall-duct obstruction is present, colic occurs, so that in every case of gall-duct colic it must ever be remembered that since this colic is often due to the obstruction of the common duct from the pressure of the enlarged head of the pancreas, pancreatic lesions should always be suspected. Pyloric and duodenal spasm are likewise caused by obstruction due to the same cause. In all cases the obstructive symptoms are a late manifestation of the pancreatic disease.

Closely related to the pancreas are the large ganglia of the sympathetic. Pressure upon these ganglia causes a disturbance which is reflected as pain through the medullated nerves supplying the body wall. Pressure upon the superior mesenteric vessels

and nerves will produce lesions referable to the small intestine. Should inflammation be communicated to other organs we have the signs and symptoms of inflammatory trouble in these organs in addition to the symptoms due to the pancreatic lesion. Not only at the time of its activity, but for long years afterward, inflammation manifests its presence by the pain and distress due to the drag and pull from adhesive formations which it has left as its heritage. Should the bowel be at fault the pain is very often relieved when belching of gas occurs.

Character of Pain. Sudden acute pain in the epigastrium, accompanied by shock, should, in the absence of lesions indicative of disease in other abdominal organs, focus our attention on the pancreas. All of its acute diseases, such as inflammation and hemorrhage, cause pain of a most agonizing type accompanied by tenderness on pressure. Should the pain be due to hemorrhage it is of an intermittent character, commencing with great severity and gradually disappearing, to reappear on the renewal of the hemorrhage. In chronic pancreatitis, even though an abscess has formed, there is usually an absence of pain. However, this is not always the case, for the pain may be severe and paroxysmal, and the tenderness in the epigastrium may be excessive. Cysts are generally without pain. Calculus, when it lodges in the diverticulum of Vater, is, as a rule, most painful, but it may exist for years in the body of the pancreas without causing pain.

In this connection Schmidt says: "It is well to think of the possibility of pancreatic lesions in all cases of apparent peritonitis, or intestinal obstruction. The same holds true of all cases of colicky abdominal pains which follow a trauma, blows in the epigastrium, etc. If in these conditions no indication is found in the urine, but glycosuria appears spasmodically or constantly after the attack of pain, the suspicion of a pancreatic lesion becomes strong. The opinion is much strengthened if, in addition to these signs, the stools show an insufficient digestion of albumins and fats, and physical examination justifies the consideration of pancreatic disease."

Location of the Pain.—Pancreatic pain, when present, is generally in the left epigastrium, and radiates to the left inguinal region, or to the back under the left scapula. This is a distinguishing feature from gall-bladder disease, which generally causes a pain under the right scapula. Should the pain be present in the epigastrium and radiate around to both sides of the thorax, it generally indicates a calculus disorder. If the celiac plexus be involved (malignant growths, inflammatory swelling, etc.), the pain radiates to the cardiac region and resembles angina pectoris.

Chauffard claims that the initial pain in the left epigastric region, which is common in pancreatic disease, is most probably due to a neuralgia along the splanchnic nerves and their anastomoses. As the solar region becomes involved the pain takes on its typical localization and its deep agonizing character. The head of the pancreas is closely associated with the biliary apparatus and if diseased may involve the common duct and so cause pain referred to the biliary areas, while disease of the body is referred principally through the distribution areas of the nerves associated with the splanchnics.

Tenderness. Tenderness in pancreatic lesions is present in the epigastrium, and is most pronounced on deep pressure. This pain on pressure may represent either the peripheral local tenderness, as found in the zones of Head, or, if present only on deep pressure, may be indicative of the irritation which has occurred in the retropancreatic tissues. These structures are supplied by spinal nerves, so that at least a portion of the pain found on deep pressure is due directly to the pressure exerted by the examining hand upon the hypersensitive sensory terminations of the spinal nerves. The other part of the pain is due to reflex tenderness in the skin and subjacent tissues, the nerve distribution of which is derived from the same cord zone as is the nerve distribution of the pancreas.

Because of the absence of peritoneum on the posterior surface of the pancreas, and of the intimate relationship which it has to the postabdominal wall, pressure made to either side of the second or third lumbar vertebræ is also provocative of considerable pain.

In diabetes, which has as one of its chief pathological phenomena a change in the islands of Langerhans, there is often present, as pointed out by Beal, tenderness on deep percussion or on pressure over the head of the pancreas or the descending colon.

Position of the Patient.—The pain in diseases of the pancreas is most severe in the continued dorsal position; therefore it is worse at night. In cysts and neoplasms, the dorsal position, in particular, is very painful; but on turning to either side the pain is relieved.

DISEASES OF PANCREAS CAUSING PAIN

The diseases of the pancreas producing pain are: (1) pancreatitis, acute and chronic; (2) calculus disease of the pancreas; (3) cystic disease; and (4) malignant disease.

Pancreatitis.—*Acute pancreatitis* is of two types: hemorrhagic and inflammatory. The acute variety, especially when it is hemorrhagic, is one of the disasters of medicine. Coming on with great suddenness and with no appreciable warning, with its most severe and agonizing pain and the associated symptoms of collapse, it seems to be a prognosticator of the nearness of death. In its onset the pain may be so violent that even morphin injections will not relieve it. However, it gradually becomes less severe, but does not entirely pass away and has a tendency to become paroxysmal and to be increased by movement. This first pain, caused by the violence done to the peritoneal tissue, is accentuated later, probably, by beginning sepsis, fat necrosis, or other effects of the pancreatic disorder. The pain may be referred to the epigastrium or, in some cases, to the entire anterior abdominal wall. In other instances it may be referred to the lower abdomen to such an extent that a low abdominal incision has been made under the mistaken impression that the lesion was in the pelvis (Deaver).

Tenderness is present above the umbilicus, generally to the right of the median line. In many cases it is very slight, though generally on a careful examination it is elicited. "It becomes more marked if the case progresses to suppuration, especially with the formation of a mass which is practically always tender" (M. F. Richardson).

Fitz's Rule. In relation to acute pancreatitis Fitz has formulated the following rule, namely, that acute pancreatitis is to be suspected when a previously healthy person, or sufferer from occasional attacks of indigestion, is suddenly seized with violent pain in the epigastrium, followed by vomiting and collapse, and in the course of twenty four hours by a circumscribed epigastric swelling, tympanitic or resistant, with slight rise of temperature. Fat necrosis, likewise, is generally present.

Symptoms of acute pancreatitis associated with the pain are: (a) vomiting, which is almost an invariable accompaniment, the vomitus at first consisting of food and then of blood; (b) belching of gas; and (c) hiccoughs, persistent and uncontrollable. Acute pancreatitis is frequently confused with intestinal obstruction, but the shock, slow pulse, and cyanosis present in acute pancreatitis are rather characteristic. In intestinal obstruction the pain may be localized in any part of the abdomen, while in acute pancreatitis it is localized in the epigastrium. Jaundice, the rapid production of free fluid in the peritoneal cavity, absence of fecal vomit, and the development of a tumor in the epigastrium are confirmative of pancreatitis and negatory for intestinal obstruction.

Subacute Pancreatitis. The course of a pancreatitis of a mild type is variable. It generally begins with a slight pain in the epigastrium, coming on a few hours after meals. The pain gradually becomes worse until it resembles biliary colic. After an acute attack of pain there is a period of freedom; then, suddenly, the patient again has a most severe paroxysm. Gradually, the pain becomes less intermittent and more continuous. All these pains are most pronounced in the epigastrium, but may radiate to the back, between the shoulders, to the region of the appendix, to the legs, or to the lumbar region. In some cases the epigastric pain may be lacking, while the referred pain is present.

Tenderness is variable. It is found in the epigastrium, either to the right or to the left of the median line, depending upon the part of the pancreas which is involved in the inflammatory process. Pus when it forms generally gravitates toward the back. Then the most severe pain is felt in the groin.

Associated symptoms of subacute pancreatitis are: (1) collapse; (2) frequent and small pulse; (3) temperature but little raised; (4) face of grayish pallor, with signs of anxiety; (5) mind clear, with little delirium; (6) tongue dry; (7) retching and vomiting, the vomitus frequently containing bile, seldom fecal matter or blood; (8) tumor mass present in the upper abdomen; (9) peritonitis beginning and spreading downward, but with no decided resistance to the abdominal wall; (10) emaciation and asthenia developing and progressing till death ensues.

Chronic Pancreatitis.—Either acute or subacute pancreatitis may persist and become chronic. Here the epigastric pain may be severe or very mild. It may be continuous or paroxysmal. In some cases it resembles a gall-bladder colic, except that the pain is not over the gall-bladder region. It is more to the center of the epigastrium and has a tendency to radiate to the left side, while the pain in gall-bladder colics has a tendency to radiate to the right side. Chronic pancreatitis is also associated with jaundice, which gradually becomes more severe; it also causes weakness, debility, emaciation, the presence of a tumor mass in the epigastrium, and frequent diarrhea. Cases of chronic pancreatitis have been reported in which pain was felt in the left iliac region or under the ninth or tenth costal cartilage on the left side.

Pancreatic Calculi.—Pancreatic calculi cause a colic somewhat similar to the colic due to gall stones, with the exception that in gall-stone colic, pain is referred to the right shoulder and is present in the right side of the epigastrium, while the colic of pancreatic calculi is generally in the left side of the epigastrium and radiates to the left shoulder. It is also noticeably different from gall-stone colic in the infrequency with which jaundice is associated with it. Reasoning from the probability of chance, 1.

Line runs from umbilicus to axilla

2.

Gall bladder point of tenderness

3.

Bisects the right angle

4.

Desjardin's point of tenderness 2¼ inches from umbilicus

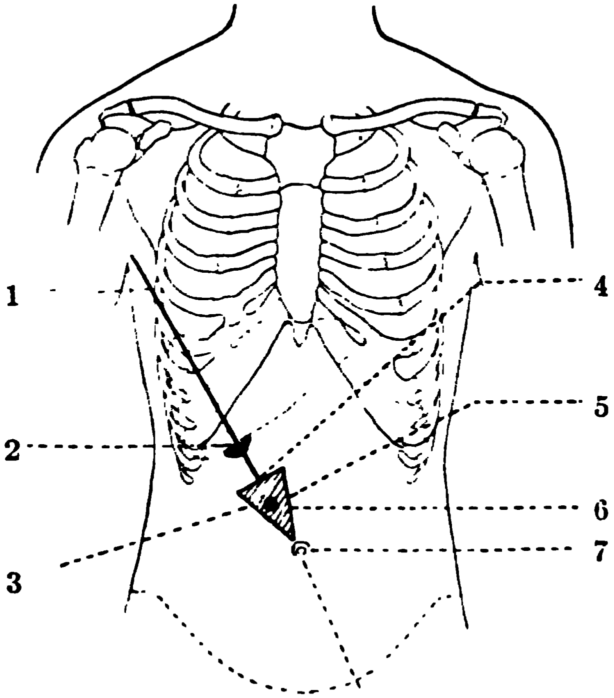

FIG. 132.—PAIN AREAS IN DISEASE OF PANCREAS.

5.

Pancreatic choledochus point of tenderness

6.

Location of common duct corresponds to the interval between second and third lumbar vertebræ

7.

Umbilicus is at level of the interval between the third and fourth vertebræ pain of a typical duct-colic type is more likely to be due to obstruction of the gall ducts than to obstruction of the pancreatic ducts, for gall stones are four or five times as common as pancreatic stones. In some cases of pancreatic calculi pain may be absent, with only a soreness in the epigastrium, or an aching in the upper lumbar region. When at its height the pain may be associated with hiccoughs, vomiting, rigors, cold sweats, and collapse. In one case in which pain was present in the left iliac fossa considerable free fluid was found in this fossa. In another case pain was present after the first six or eight hours only in the region of the ninth and tenth costal cartilages on the left side.

Cystic Disease of the Pancreas.—The distress in cystic disease of the pancreas may vary from a feeling of uneasiness and discomfort in the epigastric region to one of the most severe pain. It also may be broken by acute exacerbations, probably due to the sudden increase of tension in the cyst walls, which, in turn, is caused by a sudden increase (frequently due to hemorrhage) in the volume of the cyst contents. Like other varieties of pancreatic pain it is generally confined to the upper abdomen, but may radiate to the back and has been known to strike down into the testicles.

Cancer of the Pancreas.—The pain of cancer of the pancreas is the result of pressure on the neighboring structures or on the pancreatic tissues. It may be very mild or very severe, continuous or intermittent. It frequently starts under the costal cartilage of the left side and gradually extends toward the midline, low in the epigastrium, radiating around one or both sides to the shoulder or to the back (generally to the left side). It is worse at night; paroxysms are frequent and give a corset-like constriction. Because of its pressure on the gall duct, over-distention of the gall bladder occurs, producing a most severe gall-bladder colic. Pressure on the pylorus may be the incitor of a pyloric or gastric spasm. Curtin speaks of a case of cancer of the pancreas in which the pain radiated to the inguinal canal, back of the testicles and perineum, and down the thighs as far as the knees. In his case the most prominent symptom was a girdle sensation about the level of the tenth costal interspace. In cancer of the pancreas the patients generally assume a posture in which the body is bent forward and the knees drawn up.

CHAPTER XXVIII

THE SPLEEN

GENERAL CONSIDERATIONS

Anatomy.—The spleen is the largest ductless gland in the body. It is situated in the left hypochondrium and is in intimate anatomical relation to the digestive apparatus. Therefore, it is particularly prone to enlargement in diseases of the liver, stomach and intestines. Any acute enlargement is painful.

A small part of the superior surface of the spleen is in intimate contact with the diaphragm in the vicinity of the esophageal opening. The contact is very firm and so close that any disturbance in the spleen would cause some related change in this part of the diaphragm, so that disorders of the spleen may exert traction on this section of the diaphragm and so cause irritation to the peripheral branches of some of the intercostal nerves distributed on its lower surface, with consequent pain, which is referred to the body wall.

Nerve Supply.- The spleen receives its nerve supply from the sympathetic. The fibers accompany the blood vessels to the ultimate divisions and supply the parenchyma of the gland. They are derived from the splenic plexus, a division of the celiac plexus. From the celiac plexus collateral branches connect with the right vagus, which, in turn, is in communication with the right spinal accessory and the cervical plexus. Thus we may account for the shoulder pain on the right side.

Embleton believes that "the splenic nerves are derived from each side of the semi-lunar ganglion and from each of the members of the par vagum, and thus, by receiving nerve twigs from each pneumogastric, the shoulder pain of the right side may be accounted for." This is probably not true. (See Bechterew, "Funktionen der Nervencentra," I, p. 376.)

According to Lyon, "The spleen is supplied by nerve fibers from the left splanchnic nerve, through which a control of the size of the organ is obtained. Stimulation of the splanchnics causes contraction of the organ, whereas cutting them causes splenic enlargement."

The splanchnics carry both sensory and motor stimuli. Pain in splenic disorder may therefore also be due largely to irritation of their terminal branches from increase in tension of the splenic capsule.

Character of the Pain. Many of the lesions of the spleen progress entirely without pain, though in nearly all cases, even when pain is absent, there is present a feeling of dragging or of pulling in the left hypochondrium. Sometimes there is also a feeling as of weight in the epigastrium, or a sense of tension in the splenic area. These pains and discomforts generally extend from the left side around into the epigastrium. They may be spontaneous, but most frequently are felt only on mechanical irritation, such as comes from running, jumping, or from trauma on the left side.

In splenitis and perisplenitis the pain is generally worse about four hours after eating, because at this period digestion is at its height, and the blood supply to the spleen is at its maximum. Consequently it is at this time that the spleen has reached its greatest size, the tension on the capsule is greatest, and the pain is most severe. From then on the pain gradually decreases until about the twelfth hour, when it ceases, for the spleen has returned to its normal size. The reason for this splenic enlargement is that the spleen is supposed to act as a reservoir for portal blood, which, during the active stage of digestion, is greatly increased in quantity, with a consequent increase in the quantity present in the spleen. This increase in size is the result of a vasomotor dilatation of the blood vessels of the spleen, with a general relaxation of the musculature of the organ.

A very significant feature in splenitis is tenderness of the left pneumogastric.

Of ten cases of splenitis (Embleton), in six cases the left pneumogastric was found tender on pressure, while in two cases this condition was found in the right pneumogastric.

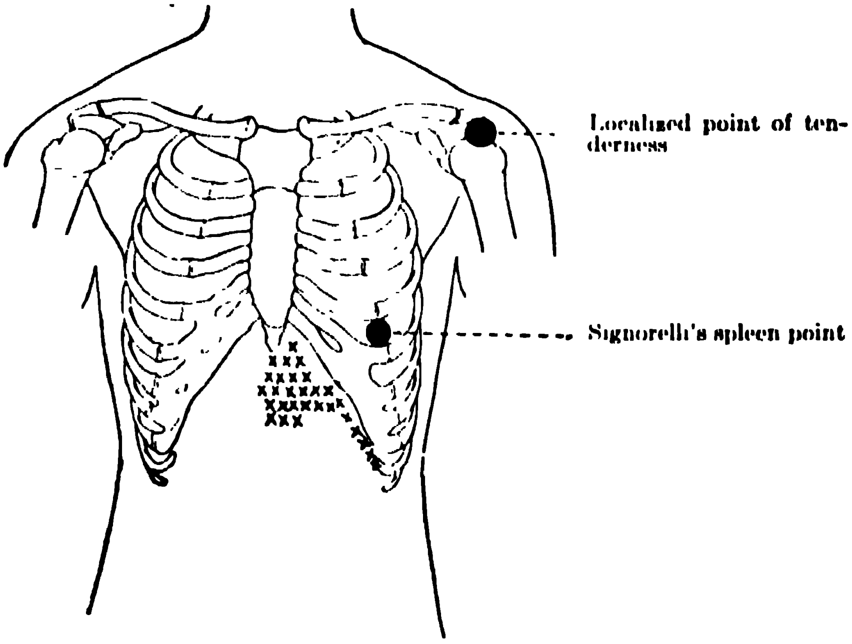

FIG. 133.—POINTS OF PAIN AND TENDERNESS IN DISEASES OF THE SPLEEN. Pain present in epigastrium, upper part along the costal margin.

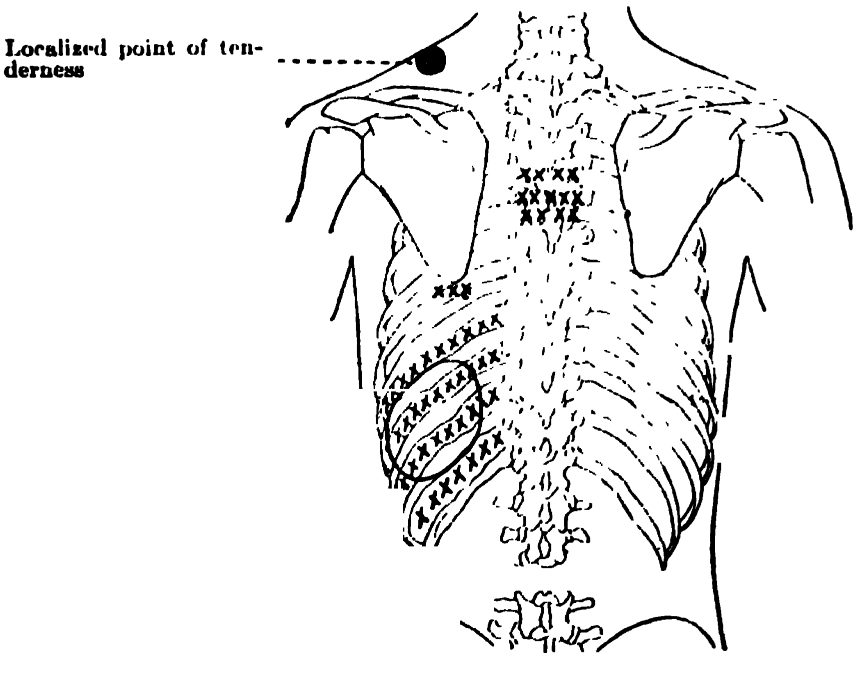

FIG. 134.—POINTS OF PAIN AND TENDERNESS IN DISEASES OF THE SPLEEN. Pain in interspaces, especially those lying directly over the spleen.

Position of Patient.—A patient suffering from splenitis generally finds the dorsal position and the left-sided position painful.

Tenderness.—Localized points of tenderness are found in the shoulder over the acromion process, and at the "junction of the upper and middle third of the upper edge of the trapezius muscle." Signorelli's spleen point is near the intersection of the left fifth intercostal space and the mid-clavicular line. Tenderness is also felt, both on palpation and percussion over the splenic area.

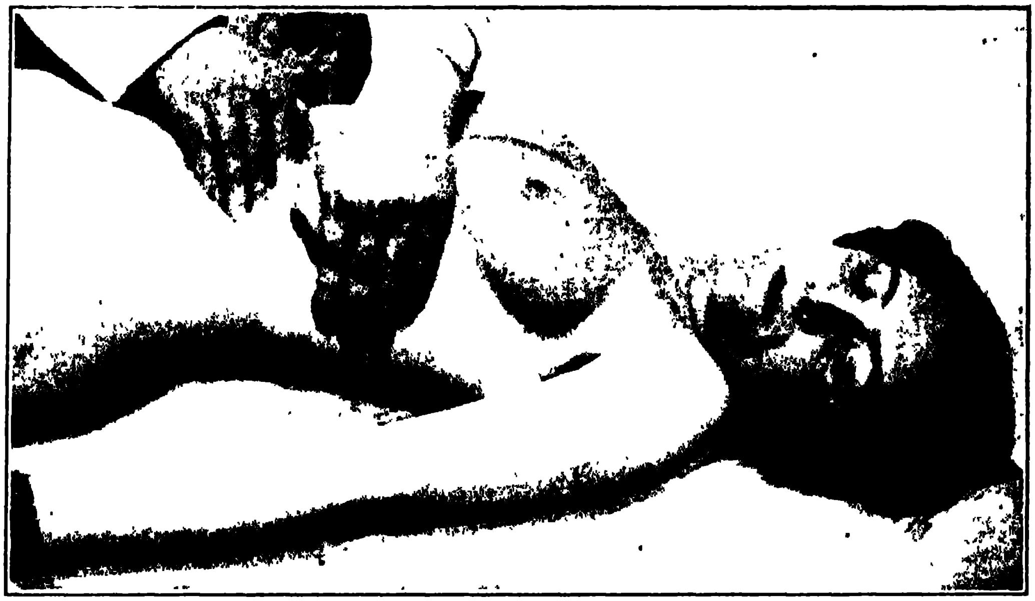

Fig. 135. Method of Palpating for Splenic Tenderness.

The patient is placed in a reclining posture with the knees flexed on the thighs, and the thighs on the abdomen; the abdominal muscles are also relaxed. The examiner stands to the right of the patient and introduces his right hand deep under the left costal border and the left hand makes pressure over the left hypochondrium. The patient now takes a deep breath and if the spleen is tender, pain is complained of when it comes in contact with the examiner's hand. In case of enlargement the deep inspiration may not be necessary.

Factors Influencing Pain.—Factors influencing the onset of pain are motion, pressure, and circulation. *Motion* is a cause of pain, especially should the movement be in the form of quick, sharp jerks or jars, such as occur in running, jumping, and horseback riding. Change of position of the organ, such as happens in turning the body from the dorsal to the left-lateral position, causes a sense of tension or of pain in the left side. This is most prominent when the stomach is full.

Diaphragmatic movements, such as occur in sneezing, coughing and hiccoughing, also cause pain. Pressure on the organ also very frequently produces pain. Such pressure is exerted by the patient himself when he bends forward or backward. In either case the spleen is caught in the recess of the diaphragm and is squeezed considerably. If it is not enlarged the force of the pressure may not be great enough to cause pain; but should it be enlarged the least amount of pressure is very painful. For the same reason, straining efforts, such as take place in defecation and in lifting, are very painful. Pressure may also be exerted by the descent of the diaphragm; thus, deep breathing is productive of pain. This is markedly so should perisplenitis be present. Palpation, especially when bimanual, causes, in a tender spleen, considerable pain. The method of palpation is shown in Fig. 135. Percussion is also painful, particularly if the percussing blow is rather heavy. "Both palpation and percussion are made in the splenic area, which is marked out upon the back, by drawing two horizontal lines from the spinous processes of the ninth dorsal and the first lumbar vertebræ, these are joined by a vertical line one and one-half inches to the left of the midline of the body, and another corresponding with the left, midaxillary line" (Moynihan). Within this quadrilateral space the spleen lies obliquely between the ninth, tenth, and eleventh ribs.

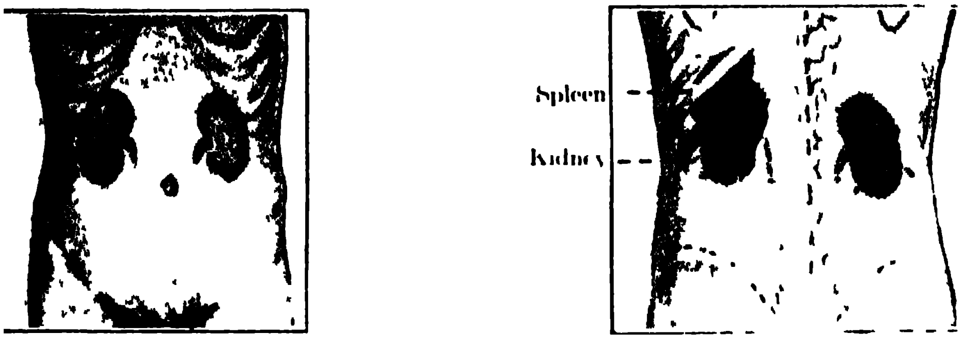

FIG. 136. LOCATION OF THE KIDNEY. (Campbell.)

Circulatory changes during digestion also produce and modify spleen pains; at this time there is present a secondary hyperemia in the spleen. If pain is already present, it is increased; or, if it is not present, it is initiated. Should the spleen be inflamed, or adhesions be present, the pain is all the more pronounced. Adhesions between the stomach and the spleen, or the spleen and the colon, are the most painful because, in these cases, during certain stages of digestion, enlargement of both organs occurs and the pull is doubly severe. Drugs, such as quinin and arsenic, lessen splenic pain, because of the decrease in the size of the spleen which they cause.

Symptoms associated with a *painful* or *tender* spleen are: Enlargement,[1] which is almost invariably present. Very often the pain and tenderness seem to vary directly with the size of the spleen. In nearly all cases of diseased spleen there is present an inflammation or some congestion of the capsule. This causes a deposit of fibrin on the peritoneal surface, or at least a roughening, which gives rise to friction when, during respiration or deep breathing, a to-and-fro motion occurs between the spleen and the diaphragm. This friction rub can be heard on auscultation, and be felt on palpation. Sometimes, in severe, active congestion, a systolic murmur can be defined on listening over the splenic area.

DISORDERS OF THE SPLEEN PRODUCING PAIN

Displaced or Movable Spleen.—Glenard states that a movable spleen may be present without any special symptoms, though generally a dragging or a sense of pulling in the back or sides, referred along the line of attachment of the diaphragm to the ribs, is present. Other organs may be affected by the displaced spleen; their circulation becomes disturbed, congestion results, and pain is produced. When the displacement is excessive the splenic pedicle may be twisted and the splenic circulation interrupted. Pain now becomes a prominent symptom, the character and severity depending upon the completeness of the circulatory obstruction. Should the veins alone be obstructed, congestion results. The pain is very severe and the spleen is increased in size. Should the obstruction be complete, both arteries and veins being blocked, the spleen at first is not increased in size, and consequently pain is not prominent. In gradual venous obstruction the pain is not as severe as it is in venous obstruction of sudden onset. In either case, whether the obstruction is complete or incomplete, complicating perisplenitis, with secondary pain, results. The diagnosis of movable spleen can be made from the shape of the tumor mass, which is oblong, with an indented border and pulsating artery on its inner surface. The absence of the spleen from its normal position, and the ability to replace the tumor mass in the cavity the spleen should normally occupy also assist in the diagnosis.

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[1] The spleen is increased in size, should its anterior border lie below the line extending from the middle of the sternal notch to the tip of the eleventh rib on the left side.

Displacement of the spleen is very rare, Glenard having found only two in one hundred and sixty cases of enteroptosis, a condition with which, naturally, one would suppose it would be associated.

Congestion.—Congestion of the spleen causes pain in nearly every case. This is well illustrated in the infectious diseases, which are almost invariably accompanied by a congested spleen and have pain in the left hypochondrium. The presence of a tumor below the left costal arch, moving with respiration, and tender to the touch, is a *sine qua non* of splenic involvement. In some cases of acute splenic congestion, accompanied by cardiac disease, pulsation may be felt. In these cases the pain may be localized to the splenic area, or may radiate in different directions. An acute congestion of the spleen, originating in the presence of a gastric ulcer, may be due to a thrombus of the splenic vein, the thrombus, in turn, being caused by necrotic tissue or blood clot arising from the ulcer.

The spleen, which in infectious diseases is enlarged and congested, may also show signs of acute inflammation. In this it does not differ from the lymphatic glands, which in the presence of infection become enlarged, and, in some cases, acutely inflamed. However, the spleen especially, because of idiosyncrasy and special peculiarity of function, seems particularly liable to involvement in all acute infectious processes. Several factors may account for this tendency, namely: (1) because of the great amount of lymphatic tissue in its substance it acts as a producer of leukocytes, and at the same time, (2) because of its relationship to the circulation, it performs the function of a filter for a portion of the blood. Thus, infectious and septic conditions, by casting detritus and bacteria into the circulation, are particularly prone to cause splenic disease. The infectious diseases causing the most marked enlargement are typhoid fever and malaria. In both diseases the spleen is enlarged and tender, and pain is complained of beneath the left costal arch. The enlarged spleen frequently compresses that portion of the lung between the diaphragm and the thoracic wall so that, on deep breathing, a fine crepitation may be heard. This, at times, has led to a confusion of the splenic lesion with pneumonia. Such a mistake is most likely to happen if the onset of the disease causing the spleen involvement occurs with a chill. Deep breathing in the presence of an enlarged and tender spleen is very painful. Because of the associated splenic congestion, paroxysmal hemoglobinuria also causes splenic pain.

In brief, it may be said that the causes of active congestion and inflammation of the spleen are due: (1) to acute factors, as microorganisms and their toxins (typhoid fever, malaria, syphilis), drugs (acetanilid and other coal tar derivatives), trauma, and local and morbid processes in the spleen (hemorrhage, embolism); (2) to chronic factors, such as anemic states (pernicious anemia, chlorosis, infantile anemia, splenic anemia, chronic cyanotic polycythemia, rickets); or (3) to passive congestions, which may be due (a) to disease of the heart and lungs (producing obstruction to the general circulation), (b) to diseases of the portal area (causing obstruction to the portal circulation), such as cirrhosis of the liver and pylephlebitis, or (c) pressure on the portal or splenic veins by tumors, adhesions, and sometimes by an enlarged and inflamed gall bladder (Lyon).

Perisplenitis.—In perisplenitis pain is almost invariably present, especially if the inflammatory process is acute. The pain varies from a feeling of discomfort to one of the greatest distress. All movements of the spleen initiate and aggravate it, particularly those movements associated with breathing, turning or twisting of the body, and bending forward or backward.

Of diagnostic importance, if the lesion is acute, are the friction sounds, which may be heard over the splenic area on auscultation. Great tenderness, also, is present on pressure over the same area. In cirrhosis of the liver perisplenitis frequently occurs. It is found in syphilitic, Banti's and Hanot's cirrhoses, while Laennec's cirrhosis rarely causes pain.

The causes of perisplenitis, according to Lyon, are: (1) localized splenic involvement, as infarct, gumma, hemorrhage, abscess, cysts; (2) generalized involvement of the splenic parenchyma in the acute or chronic splenitis of the infectious diseases; and (3) extension of inflammation from disease outside of the spleen, as pleurisy, pneumonia, local or general peritonitis, tumors or cysts.

Abscess of the Spleen. Abscess is most frequently caused by lodgment of a septic embolus; but so long as the abscess is confined to the parenchyma it gives no indication of its presence. It is only when the capsule is involved, and perisplenitis occurs, that pain is felt. The pain of central abscess and other cryptogenic forms of splenic involvement might be of great diagnostic value; but, unfortunately, as yet the pain equivalent has not been defined and correlated to the different varieties of splenic disease.

Infarct. In infarct of the spleen sudden, severe pain is felt in the splenic area. Tenderness due to perisplenitis is also present and is localized over the area of the infarct. After the first acute pain, following the lodgment of the embolus, the pain syndrome is that of a perisplenitis. The emboli causing these infarcts are most commonly due to vegetative endocarditis, in which a portion of these vegetations has been carried away in the blood current and has lodged in the splenic artery or its branches. Such a lodgment is very common, because in the spleen the arteries are end-arteries and have no anastomoses; therefore, lodgment always cuts off the circulation to a limited area and causes an infarct. Should the embolus be septic an abscess of the spleen results.

Rupture of the Spleen.—Pain in the splenic area, following a blow or a sudden trauma in the region of the spleen, particularly if it be associated with collapse and signs of internal hemorrhage, is an indication of splenic rupture. The patient, in addition to the pain, has, at the time of the accident, a sensation as of something being torn or of giving way in the abdomen. However, pain does not at once, in all cases, occur, for immediately after the injury the patient may seem but little hurt. He may be able to walk for some distance or to engage in some work before the pain comes on. A rupture may also occur spontaneously, as has been observed in a few cases of very large and congested spleens.

Tumors of the Spleen.—Tumors of the spleen, according to Monyhan, are, as a rule, painful, the pain in some cases being so severe as to prevent the slightest movement. On the other hand, the enlarged, amyloid spleen, found in septic diseases, is apt to be overlooked, because it rarely produces a pain-complex.

Cysts of the Spleen.— Likewise, cysts of the spleen, unless of very great size, are generally free from pain, though from their size they may cause a sensation of weight or of fulness in the epigastrium. Pain, when present, is in the area occupied by the enlarged spleen. Hydatids, as a rule, are painless. They usually grow from the upper surface of the gland and give a characteristic thrill on palpation.

Kala-azar, a rare disease of the spleen found in certain tropical countries, produces a splenic enlargement, which, as a rule, is painless.

Of the blood diseases causing splenic enlargement, myelogenous leukemia always causes pain. This pain, due to distention of the capsule, is frequently the first symptom of the disease. Pseudoleukemia and polycythemia also cause splenic pain, but this is rare in chlorosis and pernicious anemia. The reason for

this may be that the spleen is enlarged in only about sixteen per cent. of cases of pernicious anemia and chlorosis (Schmidt). It is only in the cases of enlarged spleen that pain is present.

SPLEEN. DIFFERENTIAL DIAGNOSIS.[1]

Symptoms	Spleen	Pleurisy	Pneumonia
Pain.	Felt in right side or is referred to the abdomen. Worse on respiration.	Localized to diseased area; not such a great tendency to be referred.	Localized over area when pleura is involved. Referred pain over the chest wall is also present.
Tenderness.	Splenic points of tenderness are present. Pressure on the lower border of the spleen (bimanual) is painful.	No splenic points of tenderness. Tenderness may be present in the intercostal spaces over the affected area.	No splenic points of tenderness. Tenderness as a rule is present over the affected area.
Râles.	May be present, due to pressure atelectasis of the adjacent lung.	May be present, due to the associated involvement of the subpleural pneumonic tissue.	Present.
Enlargement of the spleen.	Present and spleen is tender on pressure.	No enlargement.	Enlargement, septic in origin, may occur late in the disease.
Friction rub.	May be present; generally absent.	Present. Disappears when effusion occurs.	Frequently present.
Cough.	Generally not present.	Present.	Present.
Sputum.	None.	Frothy or dry.	Rusty.
Temperature.	Generally that of the causative lesion.	Generally none, or very slight.	Generally present and very high.

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[1] Splenic disorders have been confused with acute rheumatism, especially so when the splenic pain is referred to the left shoulder; but in rheumatism some of the joints are almost invariably affected, while in splenic disorders there is no joint involvement.

CHAPTER XXIX

THE KIDNEY

GENERAL CONSIDERATIONS

It is said by Howard Kelly, in what is probably a fair estimate, that over 60 per cent. of the patients with ill-defined, right-sided pain have disease of the kidney. In view of this, it is easy to understand the importance of being thoroughly conversant with kidney pains, the rationale of their production, and the method and manner of their perception.

The kidneys, unlike other abdominal viscera, are entirely retroperitoneal and do not come in intimate relationship with the other intraabdominal viscera. Their position, however, brings them into more intimate contact with the parietes and consequently with the nervous supply of the abdominal walls, which is cerebrospinal. It is extremely doubtful if any cerebrospinal fibers convey nerve impulses from the parenchyma of the kidney.[1] Yet the capsule and some of the pericapsular tissue contain cerebrospinal sensory fibers. In this way the localization of the aching pain felt in all capsular or pericapsular affections can be explained. Sympathetic nerve fibers supply the parenchyma. They are collected into the renal plexus, which in turn communicates, through the solar plexus, the lower and outer part of the semilunar ganglion, and the aortic plexus, with the lesser and the smallest splanchnic.

Nerve Supply.—The nerves supplying the kidney are derived

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[1] According to the latest researches the cortex of the kidney is derived from the mesoblastic tissue of the posterior abdominal wall; consequently there must have been, at least in the early stages of development, some slight distribution of the terminal branches of the spinal nerves to the kidney substance. Whether these persist in later life is problematical.

from the tenth, eleventh and twelfth dorsal, and the first lumbar segments of the cord (Head).

How important these areas are to kidney pain production, and how necessary the knowledge of their location is for a correct and satisfactory diagnosis, will be shown.

Etiology of Kidney Pain.- The direct cause of kidney pain is, as in all painful lesions, an irritation arising somewhere in the course of the nerve supply. Since the nerve fibers supplying the kidney are related directly and indirectly with other organs, irritation arising in their course may be referred to any or all of these related organs. Therefore, since a lesion of the kidney will cause pain and disturbance in other organs, and a lesion of other organs will cause pain and disturbance in the kidney, it requires more than the pain syndrome to make a diagnosis of a kidney lesion. An exception to this probably could be made in favor of the local tenderness which occurs upon pressure in the costal vertebral angle, when the kidney or the surrounding areolar tissue is inflamed.

The causes and the locations of nerve irritations causing kidney pain are varied; yet it is most probable that nearly all of the kidney pains owe their origin to stretching and pressure exerted upon the nerve filaments terminating in the capsule.

In this connection, Watson reports a case of apparent renal colic, in which the kidney was opened and no stone was found, but the capsule was thickened. Complete relief followed the operation. Keyes also reports relief from the splitting of the capsule in a case of chronic granular kidney. Even in a simple congestion the pain is eased by capsulotomy. However, it is probable, in all cases, that the pain is the result of an acute process, for in chronic and slowly progressing disorders, like granular nephritis or new growths of the kidney, pain is absent unless the tension of the capsule, from any cause, is suddenly increased. The pain of a severe and a colicky type instantly results. Indeed, it is claimed by Bevan and others that the pain of renal calculus is the result of a sudden increase in intracapsular tension. Bevan reports a case in which, previous to a nephrotomy, severe pain had been present, but was entirely absent after operation, although a stone, which was present in the ureter, had not been removed. After the operation its progress down the ureter could be watched with the X-ray. At no time in its descent was the slightest pain present. This is only one of the many instances which seem to show that kidney pain, that is, direct pain, is due to tension on the renal capsule. Should the capsule be thickened and non-elastic any increase in the mass of the kidney would be painful, because of the resistance to stretching offered by the thickened capsule. For this reason, it may be, that old people and rheumatics can, by the aching which they have in their backs (in the kidney areas), foretell changes of weather. The lowering of the barometric pressure may induce a kidney hyperemia, which produces tension of the capsule and thus causes pain.

In cases of intracapsular tension, in which the renal pelvis is distended with exudate, splitting of the capsule and opening of the pelvis will let out the exudate and relieve the primary pain; but a secondary congestion in the pelvis may result and produce a secondary pain.

An example of the insensibility of the kidney parenchyma to pain production is given by Cartwright (*Lancet*, 1888, Vol. II, p. 403). He says that, when in China, he was shown a specimen of a kidney removed from a Chinese cooley by an American physician. Before its removal it had extended through an opening in the loins and had suppurated from the treatment of bird dung, saliva, etc., with which it had been daily dressed; and yet, during all this time, no pain had been present.

The kidneys are in close relation with the upper parts of the lumbar plexus on either side and enlargements of their substance, new growths, or perinephritic abscesses will sometimes press upon certain of these nerves and cause pain. This pain is referred to the distribution area of the nerves upon which pressure has been made. A more complete discussion of these pains will be entered into under the heading of referred pains of the kidney.

The ureters and their nerve supply will be considered in their respective sections.

Character of Renal Pain.—In some cases, especially early in the renal involvement, a well-defined pain is not present; rather, there is experienced a sense of discomfort and distress in the corresponding iliac fossa or lumbar region. This distress may gradually increase, so that in time it becomes a well-defined pain. If the pain, when present, is of a dull, aching character, it indicates that the tension on the capsule is not of any considerable moment, but rather that the lesion involves the surrounding renal structures or is of some slowly progressing, intranephritic nature, such as that which occurs in the large white kidney of nephritis. If there is also considerable tenderness on palpation an extrarenal complication may be suspected. An aid of value in the diagnosis of intra or extrarenal lesions is that intrarenal lesions generally give rise to areas of referred hyperalgesia, while extrarenal lesions do not.

In some cases of wandering kidney, from kinking of the ureter, there is a sudden elevation of the intracapsular pressure, with a very severe, colicky pain. These attacks go under the name of Dietl's crises (see Wandering Kidney). They are accompanied, at the time of the attack, by a considerable decrease in the quantity of urine. This is followed, on the reestablishment of the urinary channel, by the voiding of a considerable quantity of clear urine which may be slightly tinged with blood. During the attack palpation will disclose a swollen and tender kidney. A calculus blocking the ureter will produce similar symptoms. Both a kinking of the ureter and the blocking of the same by a calculus are accompanied by vomiting and chills, and, in some cases, by a mild fever.

A kidney in a state of hypertension from arterial hyperemia has a peculiar rhythmical, pulsating pain, most pronounced in the lumbar region. The pain is synchronous with the cardiac systole and is the result of the increase in the intranephritic tension, which occurs during each systole.

Localization of Kidney Pain.—In kidney disorders, as well as in disorders of all other organs, there are two classes of pain manifestations, namely: the subjective, in which the pain is produced without any apparent external means of causation, and the objective, in which pain is produced by manipulation, pressure, etc. Tenderness comes under the class of objective pain. The subjective pains may be divided into the following divisions: (1) local, (2) referred, and (3) reflected.

Local Pains. Local pains, as the name would imply, are those which are produced directly in the kidney area. This area is bounded by (Gray):

(1) A line parallel with, and one inch from, the spine between the lower edge of the tip of the spinous process of the eleventh dorsal vertebra and the lower edge of the spinous process of the third lumbar vertebra.

(2) A line from the top of the first line outward at right angles to it for 2¾ inches.

(3) A line from the lower end of the first transversely outward for 2¾ inches.

(4) A line parallel to the first and connecting the outer extremities of the first and third lines just described.

The kidneys are therefore opposite the last thoracic and the upper two lumbar vertebræ and reach to within 2.5 to 3.5 cm. (1 to 1½ in.) of the highest part of the iliac crest (Piersol). (See Fig. 136.)

Thus, any pain felt in this region should lead at once to the suspicion of disease of the kidney, especially so when the pain is associated with local tenderness. If the pain is sharply delimited, and if referred or reflected pains are absent, a perinephritic inflammatory lesion should be sought.

"This is most important to a correct diagnosis in infants and children, because in them, on account of lack of development, the ability to localize pain is defective. In any case, either in them or in adults, a severe abdominal pain, of unknown etiology, especially when associated with the drawing up of the limb, etc., should always direct attention to the kidney."

Referred Pain.- By referred pains are meant those pains which are felt at a distance from the place where the irritation producing them is located. The irritation may occur at any point in the course of the affected nerve, but the pain is perceived as coming from its peripheral distribution area. In kidney lesions this is well exemplified, for pain due to the kidney may be felt in the lower iliac region, the suprapubic, the outer, middle or the inner part of the thigh. Pain, when felt in any other part of the thigh, if it is produced by lesions of the genitourinary tract, is generally due to those lesions which are located in the ureter above the bladder; while pain felt in the penis, scrotum, or in the lateral margin of the perineum and the inner aspect of the thigh, or over the lower part of the sartorius muscle (involvement of the obtura-

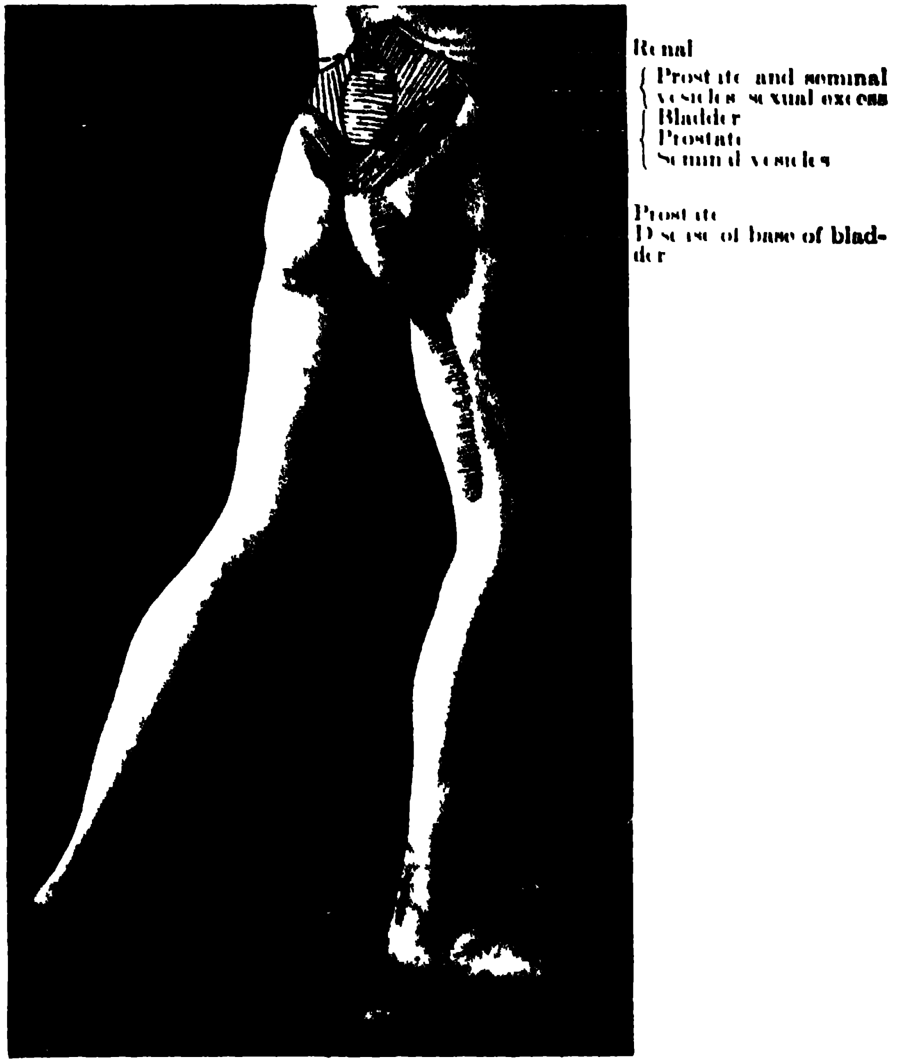

Renal
Prostate and seminal vesicles sexual excess
Bladder
Prostate
Seminal vesicles
Prostate
Disease of base of bladder

FIG 137.—AREAS OF REFERRED AND REFLECTED PAINS IN DISEASE OF THE URINARY APPARATUS (Modified from Fenwick.)

Unilateral pain of one limb is often a premonitory sign of brain hemorrhage.

tor nerve), generally indicate involvement of the ureter adjacent to the bladder.

A differential point of value in the diagnosis of the location of lesions of the kidney or ureter is that in high ureteral involvement the skin of the scrotum is not painful to pressure, but the deeper tissues are; while the reverse is true in low ureteral involvement. When the involvement is adjacent to the bladder the pain may be referred through the inferior hemorrhoidal nerve to the skin around the anus or through the perineal branch of the pudic to the skin of the scrotum. It may also be referred through the dorsal branch of the pudic to the glans penis. When, in cases of renal calculus, pain is felt in these areas it is a good indication that the stone is in, or almost in, the bladder. This is especially true should referred pains in the lower areas follow those in the upper areas, particularly those supplied by the eleventh and twelfth dorsal, the ilioinguinal, iliohypogastric, and the genitocrural nerves. The anterior crural nerve, because of its position behind the psoas muscle, is fairly well protected from pressure from any kidney or ureteral disorder, and therefore referred pain is seldom, if ever, found in the region which it supplies. Another diagnostic point of great value is that involvement of the lower third of the ureter produces increased frequency of urination, but no pain during urination. In this it differs from lesions of the bladder, which cause both increased urination and pain. The zones of Head are also of particular value in determining the exact location of the lesion.

In some, but not in all cases the progress of the descent of a calculus, and the distention of the ureter above it, can be noted by the referred and reflected pains which are present. These pains commence above in the area of the tenth dorsal and pass down through the areas of the iliac, suprapubic and the ilioinguinal to the scrotum and the penis, at which time, as a rule, the stone is in the bladder.

Referred pains are also felt in the thigh. These Schmidt regards as being due to pressure upon the twelfth dorsal nerve and upon branches of the lumbar plexus by thickening of the

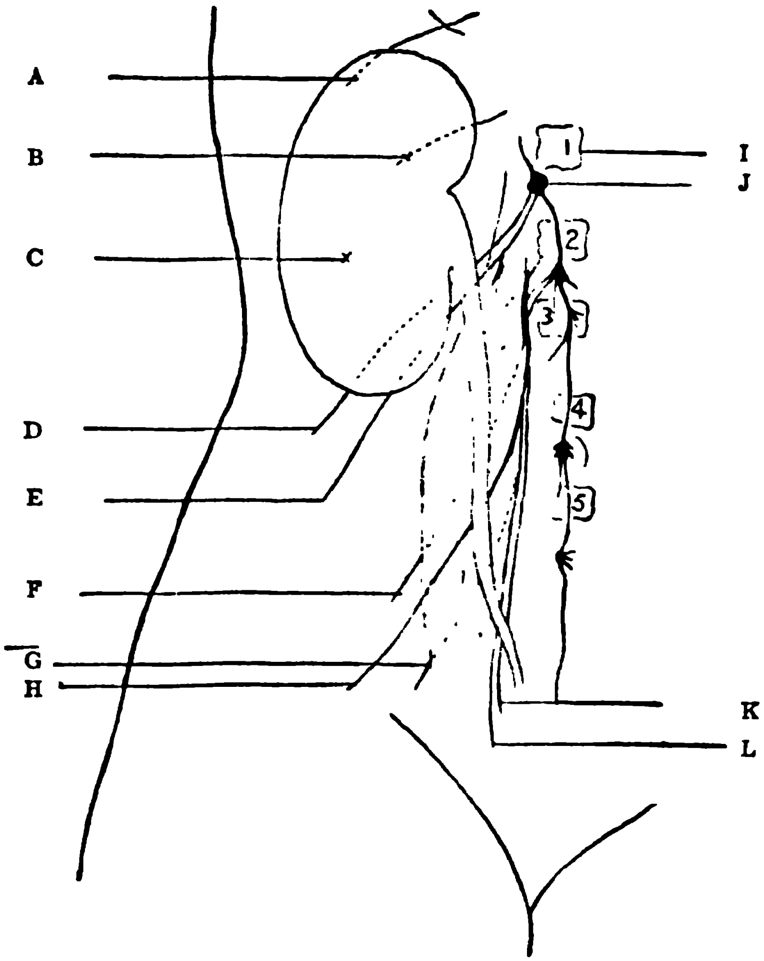


FIG. 138.—NERVES INVOLVED IN REFERRED PAIN FROM KIDNEYS.

A, 11th dorsal nerve

B, 12th dorsal nerve

C, Kidney

D, Iliohypogastric nerve, pubic region

E, Ilioinguinal nerve;

1, Base of scrotum and penis

2, Upper inner part of thigh

3, Pubic region

4, Mons veneris and labia major in female

F, Ext. cutaneous nerve: Outer side of thigh

G, Genitocrural nerve: Anterior and inner surface of thigh and leg

H, Anterior crural nerve: Anterior and inner surface of thigh and leg

I, 1st lumbar vertebra

J, 1st lumbar ganglion

K, Obturator nerve

L, Accessory obturator nerve

capsule. Such a causative agent is a far-fetched possibility, for though the amount of capsular thickening may be excessive it would not by any means interfere with the surrounding nerve structures, unless there was, at the same time, an extensive perinephritic inflammation.

For emphasis, even though it involves a slight repetition, it may be permitted to recall that the nerves involved in referred pain from the kidneys, and the areas which they supply, are: (1) the twelfth dorsal, which supplies the skin of the lower abdominal and lumbar region; (2) the iliohypogastric, (a) iliac branch, supplying the integument of the anterior gluteal region, (b) hypogastric branch, which is distributed to the integument of the suprapubic region; (3) ilioinguinal, supplying the integument of the upper inner portion of the thigh; (4) genitofemoral, which is divided into (a) genital branch, which gives branches to the skin of the scrotum, the thigh adjacent to the scrotum, and the labia majora in the female, and (b) the crural branch, which supplies the upper anterior part of the thigh, between the regions supplied by the external cutaneous and the ilioinguinal, and extends down as far as the middle third of the thigh; (5) the external cutaneous, dividing into (a) an anterior branch, supplying the integument over the anterolateral aspect of the thigh as far as the knee, (b) posterior branch, supplying the skin over the tensor fasciae femoris and lower portion of the gluteal region; (6) the obturator, which subdivides into (a) the anterior branch, supplying the integument of lower inner third of the thigh, and (b) the posterior branch, which by a branch supplies the knee joint; (7) the anterior crural, dividing into (a) the middle cutaneous, which, through its (1) external branch, supplies the integument over the rectus femoris as far as the knee, and (2) the internal branch also, which supplies the integument over the rectus femoris as far as the knee; (b) the internal cutaneous, supplying the integument over the anteromedian aspect as far as the knee; and (c) the internal sapherous, which gives sensation to the integument over the anterior internal portion of the leg, and the posterior half of the dorsum, and mesial side of the foot;

(8) the small sciatic, dividing into (a) the gluteal cutaneous, supplying the skin of the inferior gluteal region, as far externally as the great trochanter, and internally as far as the coccyx; (b) inferior pudendal, supplying the skin of the upper mesial portion of the thigh and also the perineal body and anus; (c) the femoral branches, supplying the skin of the posterior aspect of the thigh; (d) the popliteal branches, which are distributed to the popliteal space, and at times extend as far as the ankle; (9) the pudic, which, through its superficial branch, supplies the lateral margin of the perineum and inner aspect of the thigh, and the integument of the scrotum or labia majora, and through the inferior hemorrhoidal branches supplies the external sphincter

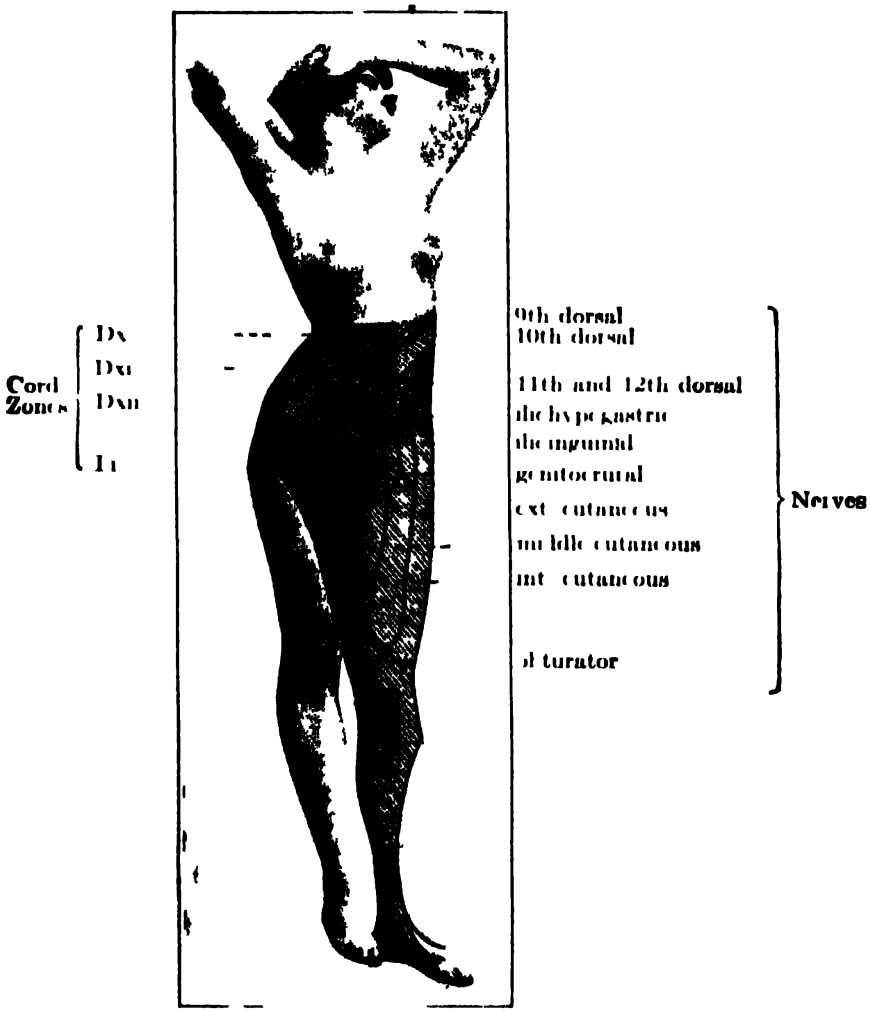


FIG. 139.—DISTRIBUTION OF CORD ZONES (according to Head) AND OF NERVES.

and the integument of the anal region (Piersol, "Anatomy," 1st ed., pp. 1320 to 1352).

Reflected Pains.– In the lesions of any viscus Head's zones should be investigated. Their presence is of very great positive, though their absence is of little negative, value.

It seems to be a rule in kidney disease, as in disease located elsewhere, that the first acute attack of inflammation almost invariably produces reflected pain, but that later attacks are not so prone to do so, because, during the first attack, the nerve terminations are so much injured that their ability subsequently to react to pain stimuli is very much impaired. This is the reason why hyperalgesic zones are not found in all cases of acute or chronic, recurring inflammation. According to Head, "The kidney is particularly associated with the area of distribution of the tenth

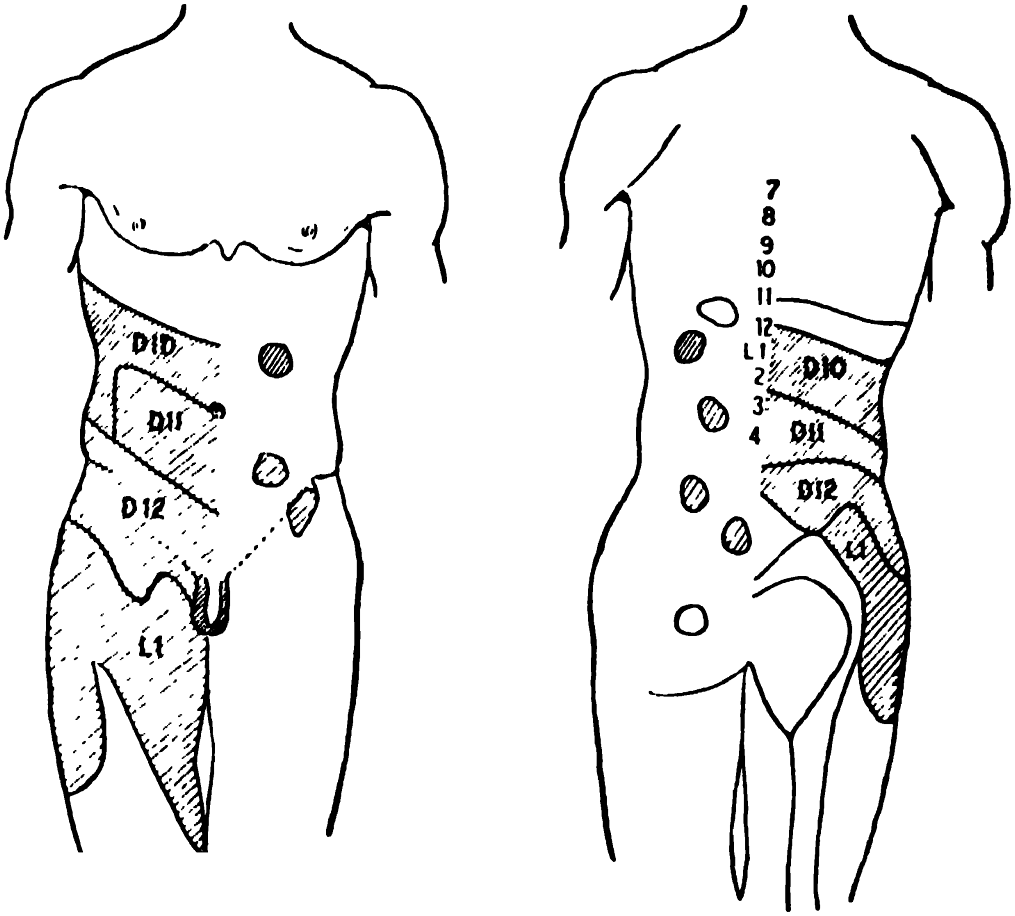


FIG. 140 AREAS OF REFLECTED HYPERALGESIA, IN 10TH, 11TH, 12TH DORSAL, AND 1ST LUMBAR VISCERAL SEGMENTS ACCORDING TO HEAD. These are the areas affected in kidney lesions.

dorsal segment, and to a lesser degree with that of the eleventh and twelfth dorsal and the first lumbar segments. Disease of the kidney, of the renal pelvis, and of the ureter seems to be particularly associated with the eleventh and twelfth dorsal and the first lumbar segmental areas."

The testicle receives its nerve supply from the same segment of the cord as does the kidney, and therefore renal lesions frequently give rise to pain in the testicle. It sometimes happens that the pain may be felt entirely in the distribution area of the lower cord segments, commonly associated with kidney disease, and not at all in the upper, so that a lesion of the kidney may sometimes be mistaken for one of the bladder.

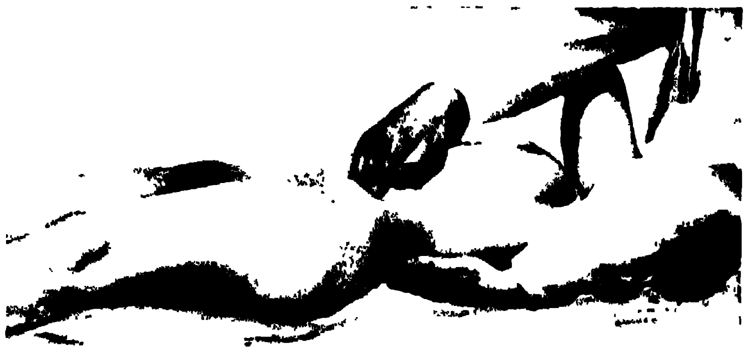


FIG. 141.—METHOD OF PALPATION IN ELICITING TENDERNESS IN THE KIDNEYS.

Renal pain also is frequently transferred across the cord and is felt in the distribution area associated with the opposite kidney, the so-called renorenal reflex of Morris, though Prout was probably the first to draw attention to this phenomenon.

Tenderness.- Tenderness is present to a greater or less extent in nearly every case of kidney disease. The only exceptions are new growths, which may be entirely free of tenderness. The technique for examination for kidney tenderness is as follows:

Have the patient's bowels thoroughly cleansed by a purgative previous to the examination; cause the patient to recline on the back; and have the limbs drawn up, and raise the shoulders (preferably on a pillow), so that the abdominal walls may be relaxed (Fig. 141). Place one hand, palmar surface, over the lumbar region. Place the tips of fingers of the other hand in the subcostal space anteriorly; then, have the patient take a deep breath, and at the same time make simultaneous pressure with both hands. If the kidney is displaced it can be felt slipping between the fingers. If it is not displaced it cannot be felt. When pressure is applied in this way to a healthy kidney no pain, though sometimes a sense of discomfort, is produced; while, on the other hand, if the kidney is diseased the patient immediately complains of severe pain. Ransohoff palpates simultaneously on both sides, with the thumbs along the last rib from within outward, and thus finds the tender foci. E. H. Thompson gives a somewhat similar method for eliciting tenderness in kidney lesions, especially in renal calculus. "He stands behind the patient and places the thumbs of both hands under the last ribs and then so spreads the fingers over the abdomen that when the patient relaxes the abdominal walls, by bending forward, the kidneys are pushed up toward the spine; then, as the patient straightens up, the thumbs are strongly pressed in. If a renal calculus is present the patient will quickly bend over to the affected side."

In some cases it occasionally happens, in kidney lesions, that contraction of the psoas muscle may cause pain. This may be demonstrated by having the patient, after having flexed the thigh upon the abdomen, suddenly straighten the limb. The pain, so produced by this maneuver, is deep down in the iliac region of the side involved.

The points where tenderness are most marked are (1) in the subcostal angle, between the margin of the erector spinæ and the last rib; (2) on the outer surface of the thigh, about the iliac crest; and (3) on the abdomen, below the free margin of the tenth rib. The tenderness may be divided into the superficial and the deep.

Superficial tenderness and hyperalgesia are useful in outlining the zones of Head, while deep tenderness is a means of practical value in the diagnosis of deeply situated lesions. Should tenderness be associated with edema it is almost pathognomonic of a deep-seated inflammation. Percussion is very useful in exactly localizing the boundaries of renal tenderness.

Tenderness of the lower segment of the ureter can be determined by palpation through the vagina or rectum. In case of inflammation, pressure exerted upon it produces pain, which is referred to the same areas as is the pain due to involvement of the lower segment of the bladder. Tenderness is very marked in tuberculosis of the ureter, or in ureteropyelitic inflammations. In some cases a stone, if lodged in the lower segment of the ureter, can be felt from the vagina or rectum by the palpating finger. The upper segment of the ureter cannot be satisfactorily palpated.

Factors Influencing Production of Pain. Factors influencing the production of pain in kidney and ureteral lesions are:

(1) *The Position of the Patient.*—The patient always assumes the posture of greatest ease. In inflammatory lesions he may lie on the side in which the lesion is located, although as a rule he lies upon the opposite one. However, in nephroptosis the patient is most comfortable when lying upon the healthy side. During an acute renal attack he reclines in a semi-prone position, with the back slightly arched,

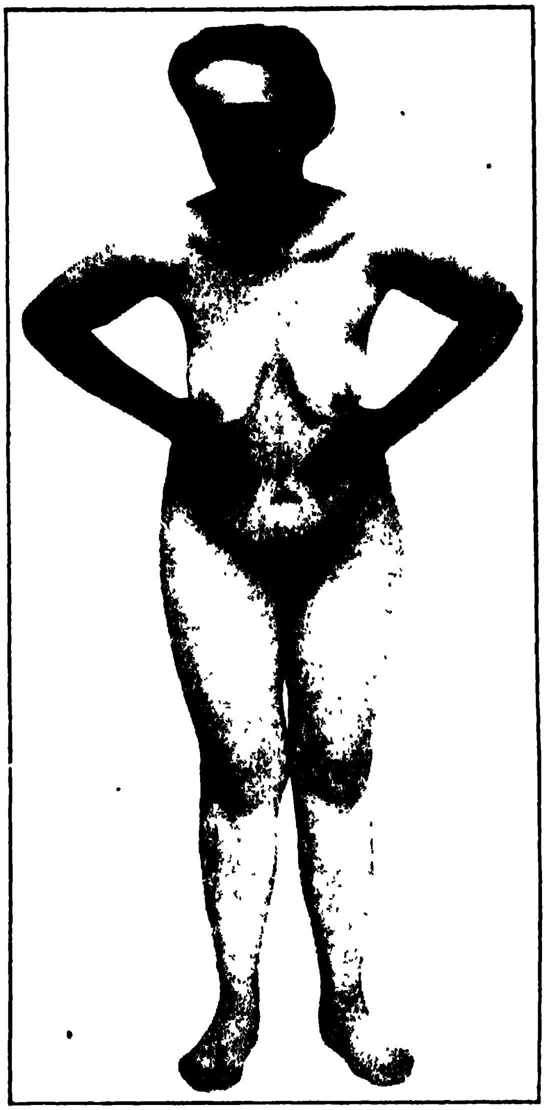


FIG. 112. POSITION ASSUMED IN KIDNEY DISORDERS, URETERAL AND KIDNEY COLIC, LUMBAGO, UTERINE AND TUBAL ADHESIONS AND DRAG ON BACK, ENTEROPTOSIS, ESPECIALLY AFTER REMOVAL OF CORSET.

and the limbs flexed upon the abdomen, so that the abdominal muscles are relaxed. When standing the patient generally bends forward and grasps the side of the body, pressing in on the lumbar region with the thumbs, and on the iliac region with the flat of the hand.

(2) *Motion of the Patient in Relation to Pain Production.*—In all diseases of the kidney or ureter due to obstruction of the ureter, or to an inflammatory process, motion of any kind is more or less painful. This is especially true of those movements associated with shock (vibration), as horseback riding, or movements in which the kidney is subjected to pressure; for instance, coughing, sneezing, deep breathing, rowing, bending, stooping, or the lifting of heavy weights. All of these movements throw great pressure upon the sensitized kidney and so produce pain. In some cases forcible flexion of the thigh causes pain. This is due to the contraction of the psoas muscle, causing either a dragging or a pressure upon the affected kidney.

(3) *Duration of Kidney Pain.*—Pain that is sharp, sudden and spasmodic, coming quickly and passing away just as quickly, generally indicates a lesion of transitory activity, probably a calculus. Pains of greater severity and more constant duration indicate a lesion of more permanence and greater gravity. The persistence of tenderness for some time after the pain has ceased is characteristic of infarct.

Absence of Pain in Kidney Lesions.—Pain is generally absent in the following lesions of the kidney: new growths, acute and chronic nephritis, and fatty and amyloid degeneration of the kidney.

Symptoms Associated with Pain Phenomena.—Symptoms associated with pain phenomena in kidney lesions are: (1) muscular rigidity, which is frequent on the affected side; (2) frequency of urination; (3) urinary tenesmus; (4) the presence of pathological products in the urine; (5) the presence of a tumor in the kidney region; (6) the presence of edema, both localized and general.

Edema localized to the kidney area is present in cases of perinephritis, inflammation, and abscess formation. Should edema be present under the eyes of those who complain of pain in the lumbar region it is a fair indication of nephritic trouble. Generalized edema only occurs late in nephritic processes.

Pain in Diagnosis of Kidney Lesions.— After a review of the anatomy, relationship, and pain-producing factors in kidney disease, it is well again to recall to mind, in a brief summary, the value of pain in the diagnosis of kidney lesions. Besides pain the principal means that are of use in diagnosing lesions of the kidney are the presence of a tumor and the character of the urine.

(1) Should pain be present in the kidney areas without tumor, and at the same time pus should be found in the urine, and this be accompanied by a cystitis, with or without hematuria, it indicates a renal tuberculosis. If pus is present in the urine, without cystitis, and with or without hematuria, renal calculus is probably present. The X ray, as a rule, will disclose the stone. In calculus the pain is made worse by movement and may be referred to the neck of the bladder. Should no pus, but, instead, blood, be found in the urine, the following should be considered as causative factors: cancer, hematuric nephritis, papillomata or angiomata of the renal pelvis, and renal congestion.

(2) If pain is present in the kidney areas and is associated with tumor, the following should be inquired into: (a) the presence of pus in the urine, accompanied by a cystitis, with or without hematuria, indicates a hydronephrosis; (b) the absence of pus in the urine and freedom from cystitis and hematuria are almost pathognomonic of aseptic hydronephrosis or of floating kidney, with or without moderate retention of urine; (c) the presence of a hematuria with neither pus in the urine nor a cystitis, most frequently points to cancer, especially if the hematuria usually occurs at night or on awakening. In all cases of kidney involvement the cystoscope should be used to tell which is the affected kidney.

Pain in the lumbar region may be due to lesions of other organs, as well as to those of the kidney, and these should be diagnosed from kidney lesions. The lesions sometimes so mistaken are iliosacralgia and iliomyalgia, and are distinguished from kidney lesions by the following: (1) they produce no enlargement in the lumbar region and no tumor can be felt by transabdominal palpation; (2) stooping and bending of the body are painful and, as Cathelin has pointed out, those afflicted by the above-named conditions are unable, upon arising in the morning, to button their boots or to pick up anything from the ground; (3) gross urinary changes are absent.

DIFFERENTIAL DIAGNOSIS OF KIDNEY DISEASES CAUSING PAIN

After a general consideration of kidney pains it is necessary to particularize and to review separately the different lesions. The order in which they will be considered is as follows: (1) movable kidney; (2) renal infarct; (3) congestion; (4) inflammation, acute and chronic; (5) peri- and paranephritis; (6) rupture of the kidney; (7) tuberculosis of the kidney; (8) new growths of the kidney; (9) pyelitis; (10) hydronephrosis; (11) renal calculus.

Movable Kidney. This is a very common lesion. Out of two hundred patients it was present eleven times, but in only one case were there any symptoms referable to it (Johnston). It is thirteen times more frequent on the right side than on the left. Even allowing for its rarity in the usual class of patients, it cannot be denied that it is the cause of a large proportion of the abdominal discomforts usually encountered. However, frequency of this condition is probably slightly exaggerated by Kelly, who says that sixty per cent. of the cases of ill-defined, right-sided pain are due to trouble in the kidney, which trouble is usually a displacement, with a kinking of the ureter and retention of the urine in the renal pelvis.

Anatomical Considerations.—Normally, the kidney is a moderately movable organ, slight elevation and depression being associated with the up-and-down movement of the diaphragm in

DIFFERENTIAL DIAGNOSIS—KIDNEY LESIONS

SYMPTOM	KIDNEY LESIONS	NEURALGIA (INTERCOSTAL)	MYALGIA (LUMBAGO)
Pain.	Generally an aching, dull, constant pain, paroxysmal at times, depending on the type of the lesion.	Sudden, sharp attacks, often following an exposure to cold or damp. Paroxysmal.	Attacks are only brought on by movement, are much worse in the morning, but as the day advances, and the muscles are exercised, the pain and soreness gradually become less.
	Motion is generally painful, especially if of a jarring character.	Motion may not increase it.	Motion increases it at first, and then as the muscular activity continues the pain ceases.
	Stooping, at least bending toward the side on which the lesion is located, increases the amount of the pain	Stooping may not produce any change in the pain symptom.	Stooping is very painful.
	Pressure on the kidney through the abdomen produces severe pain. Percussion is also painful. Pressure points associated with the kidney zones of hyperalgesia are present.	Pressure points are present. Hyperalgesic zones do not correspond to the cord zones but to the intercostal nerve zones.	No pressure points, but a general localized tenderness over the lumbar muscles.
	No pain on pinching of the muscles. Pinching of the skin may or may not be painful.	Pressure increases the pain. Pain on pinching the skin.	Pressure decreases the pain. Pain on pinching the muscles.
	Pain has a tendency to radiate to the lower limbs, to the rest of the ilium, or to the testicles.	Pain radiates around to the anterior abdominal walls.	No radiation, is localized to lumbar muscles.
	Strapping does not ease the aching, but may make it worse.	Strapping may ease the pain.	Strapping eases the pain.
	Patient localizes the pain deeply.	Patient localizes the pain superficially.	Patient localizes the pain superficially.
Urine.	Generally shows some sign of the kidney involvement. Blood in a calculus, pus in a suppuration disease.	Urine normal.	Urine normal. Frequently highly acid.
Temperature.	Septic type in suppurative lesions. Absent in non-inflammatory lesions.	Absent.	Generally absent.
Pulse.	Generally increased.	Normal.	Generally normal.
Head Zones.	May be present.	Absent. Valliex's points present.	Absent. Hyperalgesia confined to the affected muscles.

The pain of kidney lesions differs from that of uterine lesions in that in the latter the pain is a sort of a drag, while in the former the pain is more of an aching.

breathing. This freedom of motion is permitted by the rather loose connection of the kidney with the surrounding structures. It is retroperitoneal and is in close relationship with the diaphragm. Both kidneys are inclosed in perirenal fascia which divides into two layers. The anterior layer passes across the great vessels and nerves (such as those from the renal plexus, the solar, eleventh and twelfth dorsal, ilioinguinal and iliohypogastric), and joins the homologous layer of the opposite side. The posterior layer passes behind the kidney and is attached to the spine. Above, both fuse into the diaphragm, while below they merge into the fatty subperitoneal tissue of the iliac fossa. This structural formation permits considerable up-and-down movement, while anterior or posterior displacement is limited. The kidneys are joined on the right side to the liver, colon, and duodenum, while on the left the colon and the spleen are in intimate relationship. It is because of these connections that displacement frequently produces symptoms of discomfort and even of pain in these associated organs.

Pathology. In displacement of the kidney most of the pull is made upon the diaphragm and the lumbar fascia. These are supplied by the tenth, eleventh, and twelfth intercostal and the first lumbar nerves. Therefore it follows that the pain and discomfort in displacement will be radiated over the lower abdominal wall and the back. Such is the case. Yet every person having a movable kidney does not complain of pain. Indeed, in many people a considerable amplitude of movement and of displacement are present without any symptoms; it is only when the displacement begins to cause disturbances in other organs that the patient becomes aware of the pathology. From this time on the unfortunate individual has entered the realm of the nephroptotic, and is subject to constant distress and discomfort. The first distress from which he suffers is that of a pulling and a dragging in the lower lumbar region. The discomfort may become so great that the patient walks in a stooping posture, though this posture is more characteristic of the enteroptosis, with which, as a rule, nephroptosis is associated, the nephroptosis being but one symptom of the generalized condition. In renal displacement other causes for later pain production are due to kinking or twisting of the renal pedicle, which causes: (1) distention of the renal pelvis, because of complete or partial obstruction of the ureter, and (2) distention of the renal parenchyma, because of renal congestion, which is the result of partial obstruction of the venous flow. In both these cases the pain is due to the sudden increase of intracapsular pressure. Both simulate, in severity and suddenness of onset, the pain of renal calculus. In some cases a movable kidney may also be the seat of calculus, pyelitis, tuberculosis, or inflammation, and these give rise to their own typical symptoms, in addition to those of the displacement. A differential point of value in the diagnosis is that a diseased kidney is tender on pressure, while one which is only displaced is *not* tender.

Location of the Pain.- Local pain is generally absent in movable kidney, though there is present a constant sensation of pulling or of dragging in the lumbar region. In contradistinction to local pain is the frequency with which referred pains (the so called radiating pains) are found. They are due to the drag and pull upon the nerves, which lie in close relationship to the kidney, such as the eleventh and twelfth dorsal, the ilioinguinal, iliohypogastric, and, at times, even the crural or the sciatic. Pulling and dragging on these cause pain and discomfort in the lower abdominal wall, the outer and inner side of the thigh, or, in some cases, in the genitalia. The pain in the shoulder, which Kelly states is sometimes present, probably is due to traction on the diaphragm, the irritation being carried through the phrenic to the supra-acromial nerves, and thence to their distribution over the shoulder. True reflected pain is seldom found in displaced kidney, except when a state of very acute congestion, from venous stasis or inflammation, occurs in the affected organ. Then pain is felt in the kidney zones; in some cases it is felt in the kidney zone on the side opposite to the one affected. This pain is probably transmitted through the sympathetic nervous system to the cord, and thence to the body wall on the opposite side.

Kelly, quoting from Moullin, reports a case where the pain was in the epigastrium, shooting around to the back and shoulders. It invariably came on one-quarter to one-half an hour after eating; solid food made it worse, vomiting was frequent, and seemed to relieve the pain. The reclining position eased the symptoms. Kelly quotes this as a case of referred pain from the kidney, but it is difficult to see why it is not one of gastric ulcer. The vomitus at times contained blood and all the symptoms, manner of pain production, its reference, and character would indicate the lesion to be ulcer of the stomach. The relief coming after the kidney suspension was due, it would seem, more to the rest in bed than to the operation on the kidney. In addition to the symptoms detailed above as resulting from displaced kidney, there also result gall duct colic, jaundice, and other symptoms which are referable to the liver and its appendages, and are due to the pressure of the right kidney against the common bile duct.

Character of the Pain in Displaced Kidney.—The pain may be of a constant, dragging, or aching character, and may be either mild or very severe. In certain cases it is so slight that the patient is not aware of its presence unless his attention is directed to the displacement. In other cases he is always in great distress. In all cases, when present, the pain is made worse by standing or by exercising, and is generally relieved by lying down. In some women the pain, as a rule, is worse during the menstrual period. In others it is worse at night time, after the removal of the corset, while in still others it may be present when the patient is lying in bed, but promptly disappears when, on arising in the morning, the corset is put on. Generally, though, reclining in bed relieves the pain.

Paroxysmal pains are also frequent in kidney displacement. They were first described by Dietl in 1864, and are due to torsion or kinking of the ureter, with the consequent acute hydronephrosis. That such a twist or kinking is the causative agent in the production of the pain of this condition would seem to be verified from the fact that similar pains may be produced by artificial distention of the pelvis of the kidney by sterile water. In addition to the hydronephrosis, it is likely that torsion of the renal vessels (especially the vein), by causing a sudden increase of the intracapsular tension, may also be a partial factor in the pain of the so-called crises. The attack is generally accompanied by nausea and vomiting. It frequently takes place as a sudden increase of existing symptoms and, as a rule, follows excessive or violent motion, either in the form of exercise or in the jolting incident to riding horseback, or journeying in springless wagons over rough roads. In some cases indiscretion in diet may induce the pains. Generally, the attack subsides as quickly as it began, though soreness in the loin may persist for some time. The attack, as a rule, is associated with a weak and rapid pulse, cold, clammy perspiration, and signs of collapse. It generally passes off in a few hours, but may last for days. Should the pain be due to torsion of all the renal vessels, with consequent renal congestion and increased intracapsular pressure, it does not at once pass off on relief of the condition, but persists as a soreness in the kidney region for some time (Johnston). A transient polyuria follows each paroxysmal attack.

Associated Symptoms. The symptoms associated with movable kidney are:

(1) The Urinary Changes. The urine varies greatly in the daily quantity. During the time of the acute torsion the quantity of the urine is decreased and blood, albumin, and casts may be present. Immediately after the attack the quantity of the urine is greatly increased and it becomes clearer, though blood is occasionally present, as well as albumin and casts. Painful urination also is present at times.

(2) A tumor due to hydronephrosis may be noted during the attack. It disappears after the hydronephrosis is relieved. In some cases the tumor may represent only the kidney. If such is the case, the kidney can be replaced by manipulation and the tumor then disappears.

(3) Digestive disturbances, such as (a) flatulence, which is the result both of pressure by the kidney on the intestine and of the transmission of nervous stress from the kidney to the intestines, the latter being due to the intimate association of the two

organs through the nervous system, (b) nausea and vomiting, which are very frequent.

(4) Constipation may be due to pressure on and obstruction of the bowel by the kidney.

Tenderness. When a movable kidney is pressed between the fingers the patient feels a peculiar, sickening sensation, similar to that felt when pressure is made on the testicle. If, instead of the sickening sensation, pain results, some inflammatory lesion of the kidney or some condition producing increased intranephritic tension is present. Factors influencing the production of pain in movable kidney are: (1) the position of the patient; standing, especially if corsets or kidney pads are not worn, is provocative of very severe distress. Lying down immediately relieves the pain.

(2) Motion; all violent motions cause painful or distressing symptoms. Such motions as are present in jumping, running, and swimming are the most active.

Lesions with movable kidney are: (1) enteroptosis, which is a commonly associated condition, and often is the primary cause of the kidney lesion; the tympany, which may be present in nephroptosis, is more a sign of the general enteroptosis than of the movable kidney; (2) neurasthenia frequently accompanies movable kidney, and is probably due to the pressure and pull upon the abdominal sympathetic by the displaced organ.

Renal Infarction. In renal infarct pain is of great value in forming a diagnosis. The infarction may be either septic or aseptic. In the septic variety the embolus is infected and is productive of much more pain than is the non infected type. Should the embolus be infected, after the infarction has occurred there is a slow increase in the pain. Pain and chills of gradually increasing severity, arising in a case in which they previously have been absent, are signs that infection has occurred.

Causes.—The causes of pain in infarction are, according to Halperin: (1) insult to the renal plexus, (2) perirenal inflammation or inflammatory reaction, and (3) tension on the kidney capsule (Halperin).

DIFFERENTIAL DIAGNOSIS—MOVABLE KIDNEY

SYMPTOM	MOVABLE KIDNEY	GALL-BLADDER ENLARGEMENT	PELVIC TUMOR SALPINGO-OÖPHORO-UTERINE IN ORIGIN
Pain.	Dragging in affected side more toward the back. Pain is generally not severe unless the ureter becomes kinked and then the pain is most severe and is due to hydronephrosis.	Pain, dragging under the ribs, on right side anteriorly. Acute paroxysms due to passage of stone, may occur. The pain is referred to the right hypochondrium or to the right shoulder. Dietl's crisis absent. Unless acute infection occurs the pain is not severe.	Pain is of a dragging nature. Present around the crest of the ilium. Generally not severe and is referred to lower abdomen or to the iliac region.
Tumor.	Found in various places in the abdomen, moves in an arc which has for its center the normal location of the kidney.	Found in the right side even as low as the pelvic brim. Moves in an arc having for its center the attachment of the gall bladder to the liver at about the tip of the ninth costal cartilage.	Found in the lower abdomen, either in the center or on the right or the left side. Moves in an arc, having its center located in the pelvis.
	Is tender to pressure. Pressure generally produces nausea and depression. If pain is produced, it radiates to the genitals or to the thighs.	May be tender to pressure. When pain is so produced it radiates to the right shoulder and to the angle of the right scapula.	May be tender to pressure.
	Kidney is absent from the normal position. Tumor can be replaced in the region in which the kidney should have been found.	Can be pushed up underneath the liver but can not be pushed into the lumbar region because the kidney is present in its normal position.	Kidney present in its normal location. Tumor is connected with some of the pelvic viscera.
	Convexity of tumor is internal.	Convexity of tumor is downward.	Tumor as a rule is rounded, but may contain irregularities.
Pelvic Examination.	Negative.	Negative.	Discloses tumor generally attached to some of the pelvic viscera by a pedicle, which can usually be felt.
Jaundice	Absent.	Frequently present.	Generally absent.
Urine	Intermittent or increased in quantity. No bile.	Normal quantity. Bile frequent.	No increase. No bile.
Temperature	Absent.	Frequently slight.	Absent.
Artificial Dilatation. Renal Pelvis	Produces pain similar to that of which the patient complains.	Pain is not the same.	Pain is not the same.

Type of Pain.—The pain is sudden, burning, or stabbing in character, and is entirely free from any tendency to paroxysms. It may be felt in the central part of the abdomen (Johnston) or may be without any definite localization. A point of value in the diagnosis of renal infarct is that in no case does the pain radiate into the inguinal region or to the genitalia. Violent motion of all kinds, such as running, jumping, coughing, and sneezing, increases it greatly. The position of greatest ease is one in which the patient reclines on the side of the lesion. Tenderness is present over the affected kidney, particularly toward the back in the costo vertebral angle. Anteriorly, the abdominal muscles are contracted and render difficult deep palpation, so that deep tenderness is hard to elicit, although the diffuse tenderness which is present is easily defined. Percussion is a valuable means of diagnosis in this disorder and more definitely localizes the tenderness than does palpation.

Differential Diagnosis. Conditions causing pain from which renal infarction must be diagnosed are: (1) appendicitis, (2) gastralgia, (3) perforative peritonitis, (4) acute ileus, (5) gall stones, (6) lead colic, (7) embolism of either of the mesenteric arteries, (8) gastric crises, (9) lesions of the kidney or of the ureter, such as (a) torsion of the ureter, which may occur in wandering kidney, (b) paroxysmal exacerbations of chronic nephritis, (c) calculus colic, (d) pseudocalculus colic, from plugging of the ureter with débris, of either tuberculous or neoplastic origin, blood clots, or hydatids, or from obstruction from catarrhal swelling of the mucous membrane, or from functional spasm of the ureter.

Associated Symptoms. Symptoms associated with renal infarct are: changes and variations in the quantity of the urine. In the early stage of the attack the secretion of urine may be greatly diminished or may entirely cease. The urine also always contains blood, which, in the non-infected cases, may be present alone, but, if the infarct is infected, pus and bacteria are also to be found. Considerable albumin and epithelial casts are present in the urine during the early stages of the infarction. Vomiting and hiccoughing are also common. Frequently there is a history of an associated or of a previous infectious disease.

Hematuric Nephralgia.—Hematuric nephralgia (Sabattier) is a term used to designate a pain of the kidney that is without a definite causative lesion. In many cases it seems to be an essential neuralgia. That there is most probably some definite organic basis for this variety of kidney pain can be judged from the association of the pain with a hematuria. The productive agency seems to be a congestion of the active type. The absence of albumin in the urine in this disorder does not argue against the presence of a congestion, for the kidney may be extensively diseased without the presence of albumin in the urine, as has been proven time after time by examination of kidneys removed for nephralgia. In hematuric nephralgia one or both kidneys may be affected.

In some cases, however, hematuria may be present without any accompanying pain. This usually occurs when coagulation of the blood has not taken place in the renal pelvis. When it has occurred, spasmodic pain, typical of ureteral obstruction, is felt. This variety of hemorrhage and pain production is frequent in renal tuberculosis, renal tumors, and the like. A part of the pain present in renal hemorrhage owes its origin to distention of the renal pelvis with blood.

The presence of pain and tenderness in association with well-defined Head's zones may be of inestimable benefit in helping to decide whether one or both kidneys are affected by the inflammatory process. The definite localization is of very great practical value in the operation of capsulotomy or suspension. Should only one kidney be displaced it is necessary to sling up only one, and it is most important to know which one.

Inflammation of the Kidney.—Inflammation of the kidney may be considered under two divisions: (1) congestion, and (2) inflammation, which, in turn, may be divided into the acute and the chronic.

CONGESTION.—Preliminary to inflammation of any kind is congestion, which is very common and is frequently encountered during ordinary colds and in various infectious disorders. It is of two types, (a) passive and (b) active. Passive congestion, as a rule, is not painful, only the active variety being so. The cause of pain in active renal congestion is the hyperemia (induced by local irritants) and the resulting tension on the capsule. It is of a dull, aching character, and is made worse on movement. Deep breathing seems to cause more distress than does simple motion. A characteristic point, differentiating congestion pain from lumbago, is that in lumbago the pain is worse in the morning and improves as the day advances; while in congestion the pain is better in the morning and is worse in the evening. Also, the pain of lumbago is increased on pressure and is eased by fixation, while the kidney-congestion pain is not eased by fixation with adhesive straps and is very severe on deep pressure. In acute congestion disturbances of sensation in Head's zones are present; the urine also shows the effect of the circulatory disturbances and contains albumin and casts (blood) to a variable degree. The quantity daily eliminated is also diminished. The use of digitalis eases a passive, while it increases an active congestion. There are all degrees of congestion. Some may be so slight that they cause but the slightest of transitory disturbances, while others may be of such severity that they produce symptoms as severe as those found in inflammation.

A case illustrating the pain phenomena in congestion of the kidney is that of a young man who, at the time of the taking of the history, had a congestive inflammatory lesion of the kidney, with an associated pleural effusion which extended as high as the fifth dorsal vertebra. He had a well-marked hyperalgesic zone extending from the spine around the body to the right iliac region. This hyperalgesic area was thought to be due to the kidney. If it were due to a nephritis, the hyperalgesia would probably be bilateral; consequently the areas of hyperalgesia would be present on both sides and would be somewhat symmetrical in outline. The areas of hyperalgesia in this patient were present only on one side and strapping did not ease the pain. (If the pain was due entirely to pleurisy, strapping the chest would probably have caused it.) Consequently, it would seem that the condition was one of unilateral congestion. The figure below is an outline in which the cutaneous hyperalgesic area is defined.

INFLAMMATION (NEPHRITIS).—Acute inflammation of the kidney invariably causes pain, the intensity of which depends upon the degree of the kidney congestion and the time which the kidney has had to adjust itself to the circulatory changes. The pain is a much aggravated form of the aching present in the kidney areas when the kidney is acutely congested. Inflammation is one of the disorders of the kidney in which sensory disturbances in Head's zones are very plainly marked. Their presence should lead, with almost a certainty, to the correct diagnosis. In renal inflammation the urine contains casts and is loaded with albumin. An interesting and valuable point in the diagnosis of this condition is the co-relation between the extent of the Head zones and the intensity of the pain and tenderness for, as the hyperalgesia (in Head's zones) becomes less extensive, the pain and tenderness also gradually diminish. A peculiarity of inflammatory kidney pains is that they never become paroxysmal, but are always characterized by dull, constant aching. Stooping is not painful, but local tenderness is marked. A good way to elicit tenderness is by percussion, and the best way to percuss is with the whole hand, the blow being delivered by the ulnar edge of the open hand. The

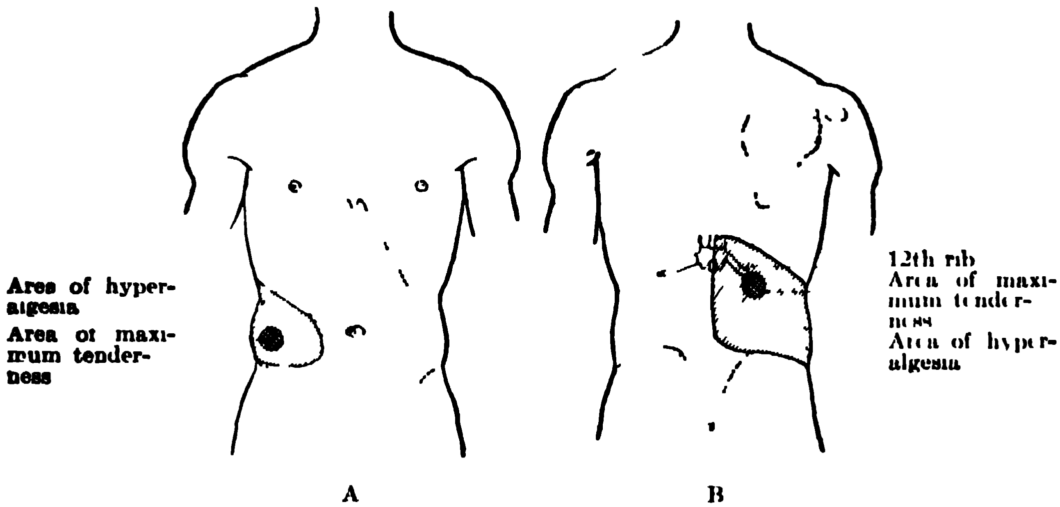


Fig. 143.—Area of Hyperalgesia in Congestion of Kidney.

referred pain is not constant. In a bilateral lesion it may be present only on one side, and in a unilateral disorder it may be on the side opposite to the one involved. The zones of Head are of particular value in deciding which of the two kidneys is involved, because they are present almost invariably only on the involved side. If the subjective pain should be on one side and Head's zones should be present on the opposite side, the latter would be the side involved. Tenderness may be present on both sides, even when only one kidney is diseased, or it may be found in the side opposite to the one in which the diseased kidney is located.

Referred pain due to inflammation of the kidney parenchyma is uncommon. When present it shows that the inflammation has extended outside of the capsule into the adjacent perirenal tissues, and that a perinephritic abscess has formed.

In some cases of nephritis pain is felt in the epigastrium. Sometimes, also, a dull aching is present across the loins. Rayer has observed that in acute nephritis there is never any retraction of the testicle or radiation of the pain into the groin, such as are so frequent in renal calculus.

In kidney disease should the pains become generalized it is very often a sign of an early fatal termination, because generalized pains are the result of a generalized toxemia rather than of the local process, and a generalized toxemia occurs only in the most severe and usually fatal cases.

Chronic Inflammation.—In contradistinction to acute inflammation, chronic inflammation, as a rule, produces no pain that might be of value in forming a diagnosis.

CHARACTER OF PAIN IN NEPHRITIS.—In many cases nephritis may be present for years, and not produce the slightest discomfort, while in other cases, very shortly after its origin, pains of great severity, generally paroxysmal in type, may ensue. These paroxysmal pains are due to an intermittent congestion of the kidney. At the time of these congestions blood, as a rule, is present in the urine.

Other pains associated with nephritis are the neuralgias and the pains due to neuritis. Headache is the most frequently associated pain. It comes on periodically (at fairly regular intervals) and, like migraine, may be limited to one side (hemicrania). It is located in various regions of the head. It may be frontal, occipital, temporal, or occipito-frontal, the occipital form being the most common. Frequently it is of a throbbing character.

ASSOCIATED SYMPTOMS.—The symptoms accompanying nephritis are: (1) the presence of albumin, casts, and blood in the urine, (2) nausea and vomiting, (3) edema, (4) dry skin, and (5) slight fever and (6) a rapid pulse.

ILLUSTRATIVE CASES.—The following cases are intended to illustrate the sensory disturbances in Head's zones and their bearing upon the diagnosis and prognosis of nephritis.

Case 1.—The first case is that of Miss A. M. K., a school girl 15 years of age, suffering from subacute parenchymatous nephritis. The illness of which the patient complained began about six weeks previous, with shortness of breath, vague pains, headache, palpitation, coldness of the extremities, digestive disturbances, eructations of foul gases, fetor of the breath, constipated bowels, pains immediately after eating, nausea, and occasionally vomiting. The patient says she has been voiding urine, as a rule, only once a day for the past six months and sometimes not at all for more than twenty-four hours. She says that her eyes puff up in the morning and that the feet and ankles are edematous. There is also some disturbance of vision. She has had measles, chicken-pox, whooping-cough, and had scarlet fever when seven years of age. Tonsillitis is frequent. The family history has no bearing on the case. On physical examination the patient was found fairly well nourished, eyes bright, pupillary reaction normal; puffiness of the lower lids, lips normal, tongue coated; tonsils appear normal, pharynx bulges slightly; adenoids are present, respiratory disturbances are absent. The pulse rhythm changes; otherwise it is full and rapid. The heart beats are normal in tone; no valve lesions are present; the abdomen is tender and slightly tympanitic; the liver and spleen are normal in size, but somewhat tender; great tenderness is

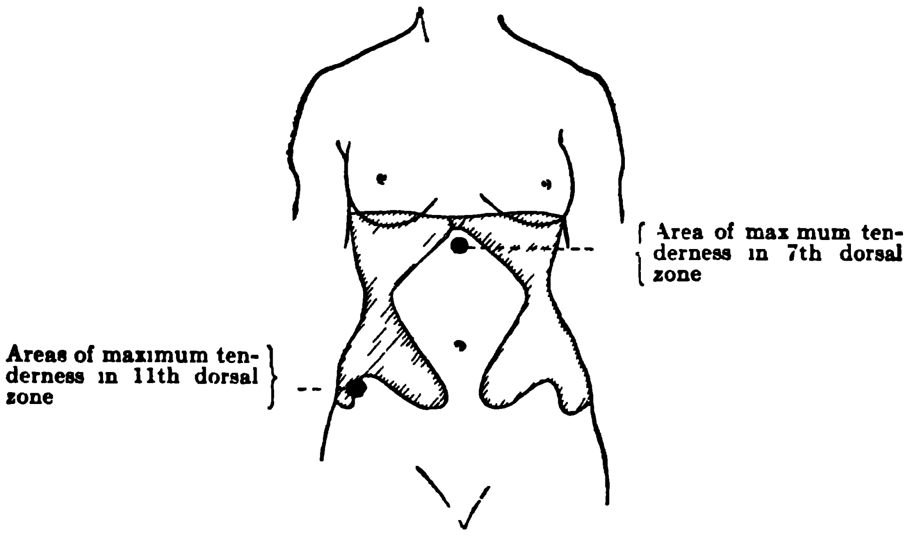

Areas of maximum tenderness in 11th dorsal zone
Area of maximum tenderness in 7th dorsal zone

Fig. 144—Areas of Hyperalgesia in Congestion of Kidneys Associated with Liver Congestion Anterior View.

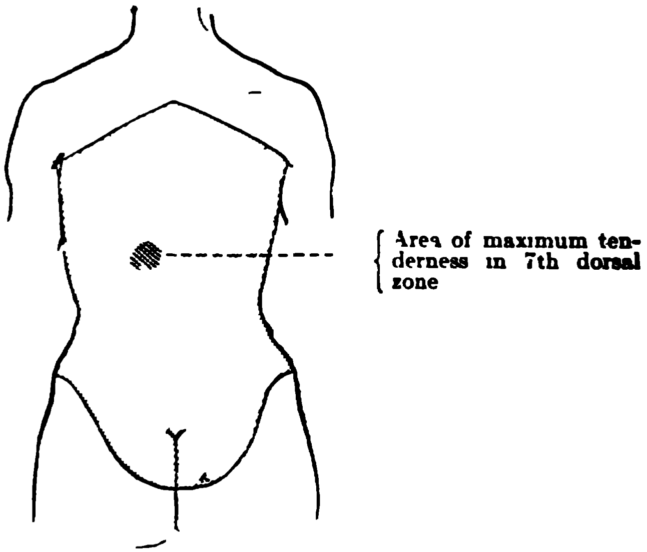
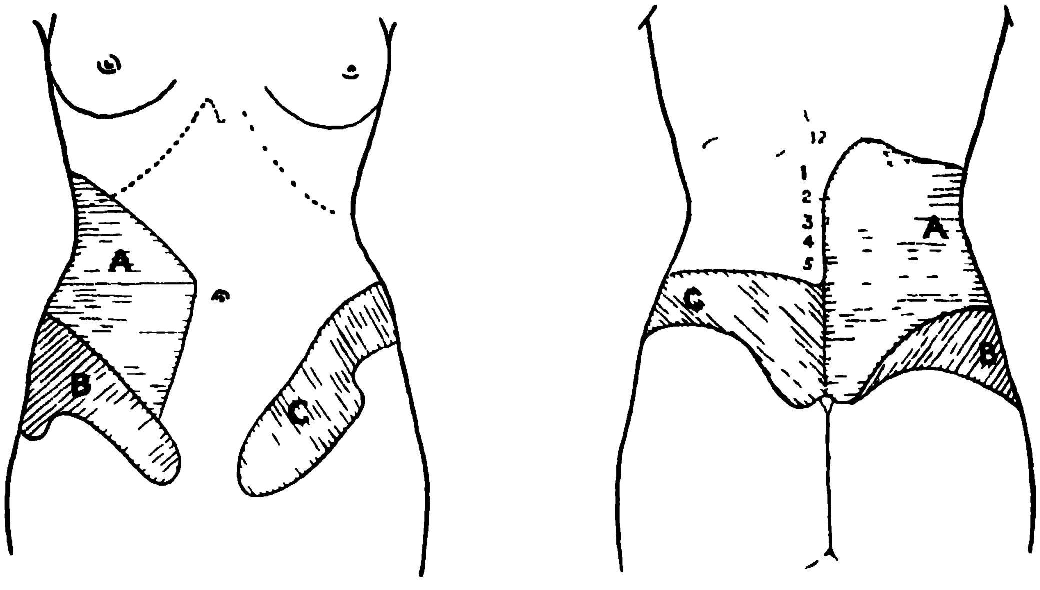


Fig 145—Areas of Hyperalgesia in Congestion of Kidneys Associated with Liver Congestion Posterior View.

present over both kidney regions; the glandular system is normal, with the exception that the postcervical glands are enlarged; the urine discloses hyalin and granular casts, albumin, a few cells, and has a specific gravity of 1.018. The patient complains of subjective pain sometimes in the back and in the side; at other times in the epigastrium. The blood pressure has remained at 140 mm. Hg. (Stanton). The general symptoms are probably due to the high vascular tension in the abdominal organs.



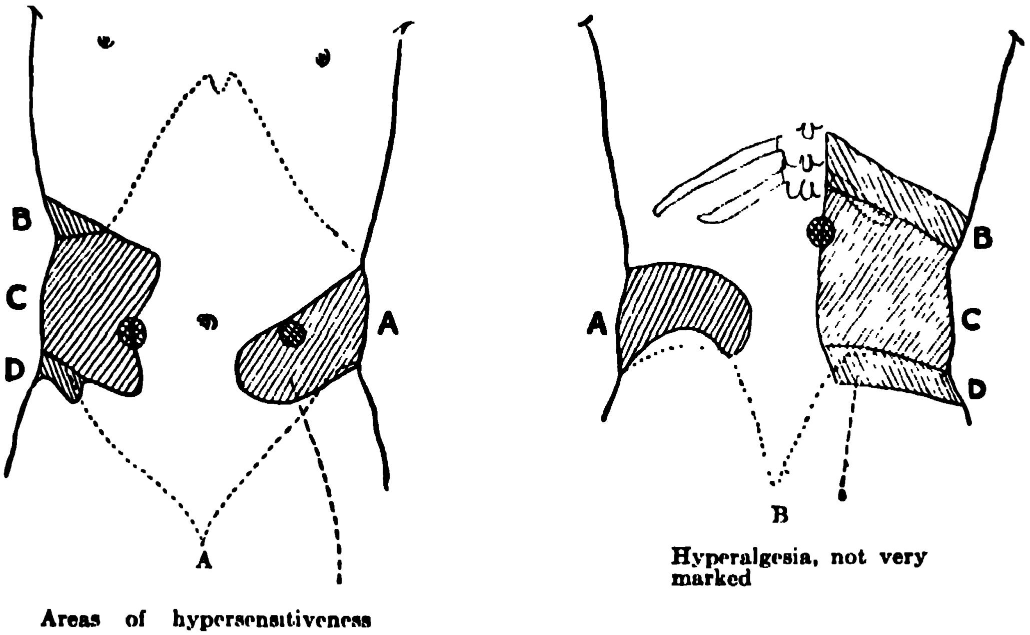
A B

FIG. 146.—AREAS OF HYPERALGESIA IN KIDNEY AND LIVER CONGESTION.

Case 2.—In the case of A. B., seen in consultation with Dr. P., the kidney areas of nephritis are well defined and are almost typical. The liver area is also present, because, at the time of examination, the liver was in a state of passive congestion.

The disease began with a tonsillitis about three weeks before the examination was made. For the past two weeks the patient has had no chills nor fever, though the tonsillar ulceration persists. Vomiting was absent at the time of the tonsillitis, but during the past week has been severe, especially in the morning. Headache is present over the right eye. It is a steady, dull pain. Nose-bleed occurred about six or seven days ago, and a slight discharge of blood from the nose has since been constantly present. Dizziness is present at times. Buzzing or ringing in the ears also is constant. The bowels are freely movable. The urine, at first, was very slight in quantity, though at the present time about two quarts are voided daily. The patient cannot rest lying down and is compelled to assume the sitting posture. The entire body is very much swollen and the swelling is worse in the morning.

Figure 146, A, shows the area of hyperalgesia, A being that of the liver, which is greatly enlarged and tender; B and C the areas of the right and left kidneys respectively. In Figure 146 B, the areas A, B, and C correspond to those for which A, B, and C stand respectively in Fig. 146, A. Notice that the areas do not meet in the median line; also notice the notch on the lower border of the kidney area, and how the lower border extends over the crest of the ilium. In the back the hyperalgesic areas meet over the median line.



Areas of hypersensitiveness

Hyperalgesia, not very marked

FIG. 147.—AREAS OF HYPERALGESIA IN NEPHRITIS. The letters do not correspond to the letters in Fig. 146.

Examination of the eyes shows them to be normal, with the exception of an internal squint of the left eye. The tongue is coated. Examination of the chest exhibits a normal heart. Fluid in the pleural cavity is absent.

Fig. 147 shows the areas of hyperalgesia about one week after the previous drawings had been made.

The area A in Fig. 147 A is becoming smaller, the diminution in size being more marked in the upper boundaries than in the lower, because these boundaries mark the upper limits of the liver hyperalgesia and, at this time, the liver was much smaller and its congestion much less; therefore, its areas of hyperalgesia would be less. The other areas are not as well defined as they were in the last drawings, but they show a concentric, though irregular diminution in size.

In Fig. 147, area B indicates the hyperalgesic zone of the liver. This area lies above area C, which was more hyperalgesic. This, in turn, was bordered below by an area D of much diminished sensitiveness, though still hyperalgesic; circles in the figures indicate the points of greatest sensitiveness. In a general way the patient is much improved; the edema is becoming less and the urine is increasing in quantity. The throat is also better. The presence of the referred liver zones would indicate that congestion of itself can produce a Head zone. The gradual disappearance as the edema became less would also be another indication of potency of congestion as a causative factor in the production of a Head zone. Why the area D, which was not present a week ago, should be developed is rather hard to explain, unless the adjacent cord cells became irritated, because of their proximity to those which were originally involved. This argument would seem to be strengthened from the fact that the hyperalgesia in this area was not as acute as in the mid-area C.

Perinephritis.—Perinephritis is the name given to the condition in which inflammation is present in the perirenal connective tissue. This inflammation generally progresses to the point of abscess formation. It is in this lesion that the most pronounced symptoms of any renal disorder appear. The most constant and important of these symptoms is pain with its associated tenderness.

Character and Location of Pain.—The pain is always severe and is found in the lumbar region. Owing to the location of the inflammation the lumbar plexus of nerves and the psoas muscle are frequently involved in the inflammatory process. When the lumbar plexus is involved, the pain is referred to the distribution area of the nerves connected with it, viz., in the cutaneous distribution area of the iliohypogastric, the ilioinguinal, the anterior crural, the obturator, and the other branches of the lumbar plexus. The distribution area of these pains is illustrated on page 677 (q. v.).

The pain in some cases of perinephritis is referred to the knee. This is apt to cause the perinephritic abscess to be mistaken for a diseased hip. A reference of this kind is very frequent when the abscess originates at the lower pole of the kidney, for abscess formation in this region is more likely to make pressure upon the anterior crural or the obturator nerves; these nerves are distributed to the skin of the lower part of thigh (ant.) and the knee, and when irritated anywhere in their course refer the irritation (pain) thus produced to these areas.

When the abscess is at the upper pole of the kidney, the intercostal nerves may be involved and pain may be referred to their area of distribution. When the sheath of the psoas is involved the abscess progresses downward and consequently affects the external cutaneous, the anterior crural, and the genitocrural; and the pain is referred to their area of distribution. At the same time, owing to the functional relation of the psoas to the thigh, pain on flexion and extension of the hip results. In fact, motion of all kinds is very painful, especially those movements in which pressure is exerted upon the kidney and the inflamed, sensitive tissues adjacent to it. Thus, bending forward or backward is almost impossible.

Tenderness.—Palpation and percussion are disagreeable to the patient. The tenderness elicited by these procedures is most marked over the renal area, the point of greatest tenderness in perinephritic abscess being over the fascial triangle of Grynfelt and Lesshaft, or, as it is called by Miller, the kidney triangle. It is bounded by the erector spinæ, the twelfth rib, and the internal oblique. Here the kidney is nearest the surface, and consequently

DIAGNOSIS OF PERIRENAL ABSCESS

SYMPTOMS	PERIRENAL ABSCESS	OSTEOMYELITIS—VERTEBRA	APPENDICITIS (abscess formation)
Pain.	Rather severe Tenderness is most marked on pressure made in the subcostal angle Tenderness also is felt on pressure made through the anterior abdominal wall The pain is eased by flexion of the vertebra The pain radiates down in the direction of the ureter	Not very severe Tenderness is most marked on pressure made over the affected vertebra Very little tenderness is felt on pressure through the anterior abdominal wall Pain may radiate down to hip, when the abscess reaches the psoas muscle it runs along this muscle to the hip	**History of a very severe pain. Generally at the time the patient comes under observation the pain may be so severe and resembles perirenal abscess Pain may be produced by the taking of food. For further pain see Appendicitis**
Vertebræ.	Fixity of vertebræ absent	Fixity of vertebræ In tuberculous disease of the vertebra kyphosis is present as a late symptom	**No rigidity of the vertebra**
Time of development	May be fairly rapid	Slow	**May be slow or rapid. Follows an acute attack of appendicitis**
Urine.	Pus blood generally found if examinations are persistently and carefully made	Pus and blood in urine are absent	**No pus, nor blood, etc., present**
Nausea and vomiting	Common	Unusual	**Common**
Tumor.	Presents below the ribs on the side affected and causes a bulging outward on that side The tumor can be felt sometimes through the anterior abdominal wall	No tumor, unless an abscess has formed to one side of the vertebra, in which case it is present The appearance may closely resemble the tumor mass of a perinephritic abscess	**Tumor mass is lower down than in perinephritis Is best felt from in front Is rather sharply circumscribed.**

pressure at this point is made more directly upon the diseased tissue. Pain is also felt in other inflammatory diseases of the kidney upon making pressure at this point, but not to the same degree as in perinephritic abscess. Tenderness on palpation and percussion is also present between the crest of the ilium and the last rib, in the midaxillary line, or somewhat posterior to it. Should a localized peritonitis occur over the inflamed kidney a marked tenderness to transabdominal pressure will be found. According to Ransohoff, a perinephritic abscess may be diagnosed from a kidney lesion proper by its exquisite tenderness on superficial pressure, because, on the contrary, in affections of the kidney proper, it requires deep pressure to cause discomfort. A further point of diagnostic importance is that, in suppuration of the kidney parenchyma, pressure made from in front through the abdominal wall causes considerable pain, while in perinephritic abscesses the greatest tenderness to pressure is in the loin just below the last rib.

Posture.—As a rule the patient stands with "thighs flexed on the pelvis. In order to relax the psoas he walks with body bent forward and with the hand of the affected side resting upon the upper part of the hip. To relax the part the trunk is sometimes bent laterally, so that the ribs approach the iliac crest" (Roberts, 127, p. 392). Roberts believes that flexion of the thigh is an accompaniment of perinephritic abscess, especially if the abscess is located at the lower third of the kidney. The flexion may be so slight as to be hardly noticeable; in other cases it may be so severe that it resists all efforts at extension. All other motions of the thigh may be painless.

Associated Symptoms.—Other symptoms of value in the diagnosis of a perinephritic abscess are:

(1) The presence of a localized, fluctuating swelling in the lumbar region. The three cardinal features of this swelling, which render its identification as a kidney lesion easy, are as follows: (a) it lies entirely on the posterior wall of the abdomen and, even when very large, does not approach the anterior abdominal wall; (b) it is diffuse and is not confined to the region

of the kidney proper; its limits, also, cannot easily be defined; (c) it is not influenced by respiration (a kidney enlargement due to disturbance in the parenchyma of the kidney will move with respiration).

(2) Aspiration of the tumor mass generally reveals pus.

(3) Gastrointestinal symptoms, such as vomiting, tympany, and constipation, are present.

(4) Jaundice sometimes occurs in perinephritic abscess on the right side.

(5) There is frequently a history of an injury or of a renal infarction. In the first, trauma is followed at first by renal tenderness, then by chills, and fever, and lastly by the tumor.

(6) In some cases there is a fixation of the lumbar spine with scoliosis, the concavity being on the side of the diseased kidney.

(7) When the sheath of the psoas is involved extension of the limb on the affected side is painful, while at the same time all other movements can be made without pain. This differentiates it from hip-joint disease.

(8) A characteristic of perinephritic disease is the high white blood count (Morris, Booth, Miller).

(9) Painful breathing, coughing, sneezing, etc., are sometimes present and may be due to involvement of the pleura.

Retraction of the testicle toward the affected side has been given as an important sign; but according to Nieden it does not occur unless a calculus nephritis is present in addition to the perinephritic abscess. This statement is doubted by Roberts (127, p. 392). When it occurs the retraction is due to involvement of the genitocrural nerve (Roberts, p. 405).

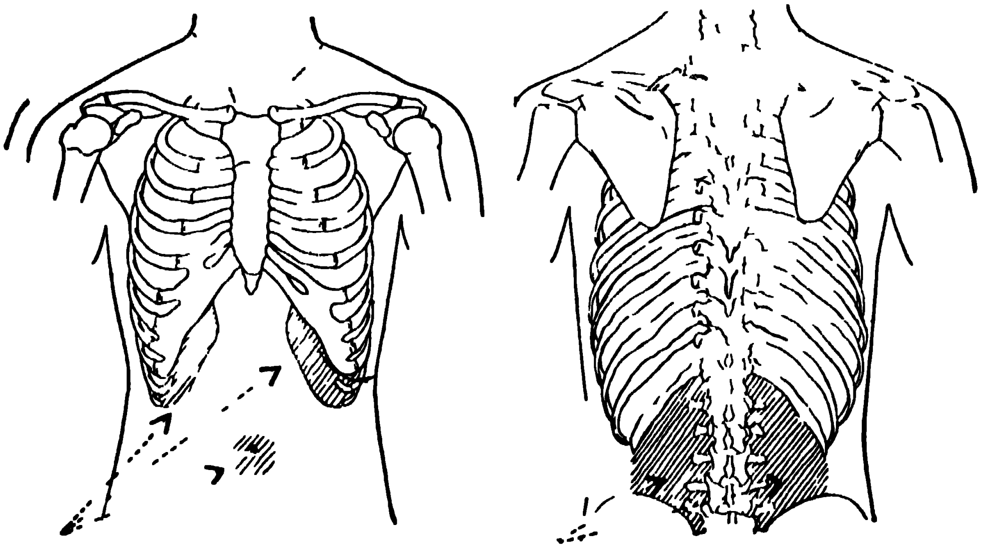
Differential Diagnosis.—Perinephritic inflammation may be confused with pleurisy. Hepatitis should be differentiated from perinephritis on the right side; splenitis from perinephritis on the left. Pneumonia also is sometimes mistaken for perinephritis. It should also be diagnosed from osteomyelitis of the vertebra and appendicitis with abscess formation.

Rupture of the Kidney.—While rupture of the kidney without pain has been reported, it is almost inconceivable how this severe lesion could occur without producing at least some pain. The rupture may tear into the perinephritic tissue; when it does so there is felt a sudden, sharp pain, not restricted to any area, but generalized and diffuse. If the rupture is such that hemorrhage takes place into the pelvis of the kidney severe pain, paroxysmal in type, ensues, and is due to the passage of blood clots down the ureter. At the same time there is a transitory hydronephrosis. One of the surest of the confirmative signs of rupture is hematuria; however, there is an exception in slight rupture of the cortex, in which, unless there is a concomitant injury to the pelvis, blood may not be present in the urine.

Following the rupture, if it has not proved fatal, a perinephritic abscess generally develops.

Tuberculosis of the Kidney.- Tuberculosis of the kidney may or may not be painful. In some cases pain is present only in the terminal stages of the disease, while in others it may be one of the earliest symptoms. According to Maylard pain is absent as long as the lesion is confined to the parenchyma, and, when pain is present in the early stages, it is more vesical than renal in origin. When present it occurs before and after urination and is associated with increased frequency of the urinary act. In these cases the symptoms are such that even in a normal bladder cystitis might be diagnosed. In all advanced cases, however, it is found, and should it be present in the absence of gonorrhea, trauma, instrumentation, or stone, it must be looked upon as presumptive evidence, especially in the young, of renal tuberculosis (Ransohoff).

Character of the Pain.--When the disease is fairly well advanced pain is a most important symptom. It is localized to the side of the kidney and may radiate to the inguinal or to the iliac regions. It may be produced spontaneously or be felt only on pressure. According to Brazy, the three points on the anterior abdominal wall where, in renal tuberculosis, pain is most likely to be produced on pressure are the paraumbilical, the subcostal, and the lumbar (Figs. 148 and 149). If the tuberculous process advances beyond the capsule and invades the paranephritic tisses; the pain and tenderness in the costovertebral angle become excessive. In tuberculosis of the kidney Head's zones of reflected hyperalgesia are sometimes present. When present they are, as a rule, synchronous with the so-called ureteral colic, due to the passage of detritus, blood clots, pieces of necrotic tissue, etc., through the ureter. The tissue and clots block the ureter and distend the pelvis of the kidney either with urine or with blood. The intranephritic pressure now becomes excessive and it is to this, and not to spasm of the ureter, that the pain, paroxysmal in type, is due.



Areas of tenderness in renal tuberculosis

Areas of tenderness in renal tuberculosis

FIGS. 148 AND 149.—AREAS OF TENDERNESS PRESENT IN RENAL TUBERCULOSIS.

There are two types of pain in renal tuberculosis. The first is the constant, steady, aching pain, which may be interrupted by the paroxysmal pains, the second type. In some instances, sudden, acute, paroxysmal pain may be present without obstruction of the ureter by clots or by pieces of necrotic tissue or other elements. It is, then, probably due to an acute congestion of the kidney, with a great increase in the intracapsular tension. Fortunately for the comfort of the patient, these paroxysmal attacks are rare.

In kidney tuberculosis tubercle bacilli often can be discovered in a centrifugalized specimen of urine obtained by ureteral catheterization.

In many cases the tuberculous disease of the kidney may not produce any well-marked pain, but rather a diffuse aching, discomfort, or a dragging sensation in the lumbar region. As sometimes happens in other varieties of kidney disease, the pain and distress may be referred to the kidney area on the side opposite to the one affected.

Diagnosis. Pain in the kidney region, in those cases in which tuberculosis is present in other parts of the body, should always lead to the suspicion of a probable tuberculosis of the kidney. The diagnostic signs of tuberculosis of the kidney are:

(1) The presence of the characteristic pain.

(2) The discovery of blood, pus, cells and tubercle bacilli in the urine. In some cases the presence of blood in the urine may precede other symptoms of the disease for many years. Precipitancy of urination is frequently present.

(3) Elevation of temperature is present in a fair proportion of cases.

(4) Increased rapidity of the pulse is common. It generally varies with the fever and is of a hypotension type.

(5) Lung symptoms, or signs of tuberculosis in other regions of the body, are often found.

(6) Enlargement of the kidney is generally an early symptom. The kidney is tender to pressure, and since the enlargement is commonly due to pyonephrosis it varies with the painful crises.

(7) v. Pirquet, subcutaneous, and Calmette reactions for tuberculosis are, as a rule, present.

New Growths.— New growths of the kidney are of two types, the benign and the malignant. In either case, pain is not a symptom of much value. The benign growths causing pain are cystic in character, and may consist of simple cysts, polycysts, or hydatids. The malignant growths are sarcoma, carcinoma, and hypernephroma (Grawitz' tumor).

ETIOLOGY.— The pain in all of these conditions is due:

(1) To the dragging upon the surrounding tissues by the kidney, because of its increased size and weight.

(2) To an increase of intracapsular pressure, from (a) a hydronephrosis, the result of a kinking of the ureter from a ptosis of the kidney, or a blocking of it by a blood clot or a particle of the malignant tissue; (b) increase in the size of the growth (a slow and gradual increase in size is not painful, it is only when the increase is sudden that the pain is pronounced); (c) a hemorrhage into the substances of the growth or into the parenchyma of the kidney. This occurs more frequently in sarcoma and carcinoma (Johnston) than in other growths. Indeed, it is claimed that in these growths pain is not produced unless an intracapsular hemorrhage has occurred. Sometimes, when the new growth penetrates the pelvis, hemorrhages ensue and hemanephrosis, with its consequent pain, results.

(3) Contracting abdominal muscles, also, may, by pressing upon tender kidneys, cause pain.

CHARACTER OF THE PAIN IN NEW GROWTHS OF THE KIDNEY.—The sensation present in these disorders is rather an aching and discomfort than actual pain, though at times, when the intracapsular tension is greatly increased, the pain becomes most acute and assumes a paroxysmal character. Because as a rule only one kidney is involved the pain is unilateral. It may be caused, and in most cases is aggravated, by violent movements, such as jarring, the lifting of heavy objects, or the carrying of a heavy weight. The pain may radiate to the thigh. This radiation is due to the pressure exerted upon the lumbar plexus by the enlarged and heavy kidney.

VARIETIES OF NEW GROWTHS.—*Cystic Disease.*—(1) *Simple Cysts.*—In these conditions the pain has been known to precede the formation of the cyst. When the cyst has formed the pain is of a dull aching type, and is varied with sharp paroxysms, which are associated with enlargement of the kidney. These exacerbations are probably due to a hemorrhage into the substance of the cyst.

(2) *Polycystic Disease.*—In this disorder, if only one kidney is diseased, the pain is on the diseased side. Should both kidneys be affected the pain is bilateral. It may be constant or intermit-

tent, is less when the patient rests in bed and is quiet, and is very much increased upon movement. As in simple cysts, hemorrhage may occur into the substance of the growth and produce great pain. Considerable tenderness on pressure is present in the costovertebral angle. The diagnostic symptoms associated with a polycystic growth of the kidney are (a) the presence of a tumor (kidney), which is mobile and contains knobs on the surface, and (b) the character of the urine, which is increased in quantity, is of low specific gravity, and contains a slight amount of albumin, casts, and blood. It also contains bodies resembling those found in the prostate.

(3) *Hydatid Disease.*—In this, as a rule, pain due to structural kidney change is absent; but in its stead is colic, due to blocking of the ureter by the booklets. These booklets can sometimes be detected in the urine.

(4) *Sarcoma of the Kidney.*—This gives rise to pain of a dull, dragging character, referred to the lumbar region or to the thigh. Paroxysms of colic occur when the ureter is temporarily blocked by blood clots or by pieces of sarcomatous tissue.

(5) A *hypernephroma* may be without pain. Its onset may be so insidious that its presence is not discovered until the size of the tumor draws attention to the condition. Then pain may ensue and aggravate further the discomfort and distress of the patient. The pain may be constant, dull, and aching, or it may be paroxysmal, the paroxysms occurring when the kidney capsule is subject to considerable intranephritic tension, either from backward stasis of the urine (a clot in the ureter) or from hemorrhage either into the parenchyma of the kidney or of the tumor. The pains may radiate into the pelvis or down into the thighs. Both the kidney and the related tumor as a rule are very tender to pressure. Hematuria is the most frequent associated symptom.

DIAGNOSTIC SYMPTOMS.—Tumors of the kidney have the following diagnostic symptoms (Piersol and Morris):

(1) The large intestine is in front of the tumor. This does not happen with liver or splenic tumors. If the colon is distended with gas it produces a tympanic mass anterior to the tumor, while

if collapsed it can often be felt as a roll of tissue beneath the fingers.

(2) Renal tumor causes an anterior bulging into the abdomen. A posterior bulging generally indicates a perinephritic abscess.

(3) No area of resonance, such as is found in tumors of the spleen, is present between the dulness of the tumor mass and the vertebræ.

(4) A kidney tumor retains somewhat the shape of the kidney.

(5) It generally does not reach the midline.

(6) There is an area of resonance on the right side between the dulness of the liver and that of the kidney.

(7) Varicocele is often present on the side of the tumor.

(8) The tumor generally does not extend into the pelvis, and generally does not move, to any considerable degree, with respiration.

Associated symptoms may also be produced from obstruction of the colon and also from traction on the spleen, the liver, or the diaphragm.

Pyelitis.—Character, Causation, and Localization of Pain.—In pyelitis pain may or may not be present, although in about seventy-five per cent. of the cases it is manifested at some time during the course of the disease. The pain is more severe in the acute varieties, or in exacerbations of the chronic forms. These exacerbations are sometimes the result of cooling of the surface, such as occurs in getting drenched, or even in having the feet wet or damp, and in being exposed to drafts or to chilling. The chilling of the surface drives the blood inward and produces a congestion of the already inflamed kidney, with an exacerbation of the pain. The pain usually is felt in the back (in the kidney area), and has a tendency to radiate to the thigh, the perineum, the genitalia, or upward to the epigastrium or shoulder. It is generally increased by pressure.

It is possible that pyelitis of itself does not produce pain unless there is a concomitant involvement of the kidney parenchyma. When such involvement occurs a slight tension of the

DIFFERENTIAL DIAGNOSIS OF TUMORS OF THE KIDNEY

SYMPTOMS	POLYCYSTIC KIDNEY	SARCOMA	HYPERNEPHROMA
Pain.	Dull aching, generally in the lumbar region.	Dull aching, or may be entirely painless.	Generally dull aching in the back. Spasmodic, colicky pains may also occur. They are due to the passage either of blood clots or of tumor tissue through the ureter.
Urine.	May show no changes until late in the disease. Blood may be present.	Ibid. Blood may be present.	Blood is nearly always present. This is most marked when the growth has invaded the renal pelvis.
Renal colic.	Not as common as it is in other varieties of kidney tumor formation.	Generally absent.	Present, time of onset varies.
Tumor.	Large, irregular mass in kidney region. On palpation a certain amount of resiliency is present.	Large; regular outline to growth.	Present, generally very large. Often the kidney can be felt on the lower pole of the mass.
Age.	Generally old people.	Generally young people.	Average age about fifty years.
Cachexia.	None.	Present.	Very common.
Fever.	Generally absent. When present, it indicates the beginning of suppuration.	No fever.	May be present.

capsule may result, and both subjective and objective pain be felt. The pain may appear in the form of an aching in the back, or of tenderness over the diseased kidney.

These renal pains may be followed or accompanied by ureteral colic, due to the blocking of the ureter by débris. This variety of ureteral colic is hard to differentiate from calculus colic. A means of distinguishing it is by the X ray, which defines a shadow if a stone is present; or by the wax tipped catheter, which shows a scratch should stone be encountered. If the pain changes to a dull, constant, or possibly throbbing type and chills and fever appear, it is an indication that a pyelonephrosis or a renal abscess is forming or has formed.

PYELONEPHROSIS AND PARENCHYMATOUS INFECTION. Inflammation of the kidney pelvis of itself may not produce pain symptoms until some secondary complication such as (1) pyelonephrosis or (2) parenchymatous infection takes place. The former, *pyelonephrosis*, produces symptoms that resemble in their complex the paroxysms of ureteral colic. Both have the same etiological relationship to pain production, which is due to ureteral obstruction. This obstruction may be caused by blood clots, fibrin, pus, necrotic tissue, inflammatory swelling, or organized exudates. A peculiarity worth remembering is that pyelonephritic pains generally precede the parenchymatous ones. *Parenchymatous involvement* also causes pain symptoms which we have learned to associate especially with kidney involvement. It is likely that the irritation of the parenchyma gives rise to sensory signs in the Head zones, while the capsule tension, also due to the parenchyma involvement, causes the achings so constantly found in the lumbar region.

Therefore, in pyelonephrosis or in hydronephrosis, the pain is due both to ureteral spasm and to capsule stretching, and Head's zones will be absent, while in parenchymatous involvement Head's zones and the capsule tension pains will be present, while the colicky pains are almost invariably absent.

DIFFERENTIAL DIAGNOSIS.—One is likely to err in the diagnosis of lesions of the kidney or of the upper part of the ureter, because involvement of the upper part of the ureter causes the pain areas to be so distributed that they correspond to the kidney zones. Yet if it is borne in mind that a ureteral colic cannot be due to a lesion of the kidney without ureteral obstruction, the conclusion may be reached that the lesion is of such a nature that it involves both the kidney and the ureter. Should pain be present in the kidney area prior to its presence in the ureteral area, and should the latter become manifest only during a severe colic, or should pain in the ureteral area disappear after the colic, with the persistence of a kidney zone, a lesion of the kidney, which causes intermittently a renal colic, may be diagnosed. Among such lesions are the following:

(1) *Pyelitis or Pyonephrosis.*- In these conditions colic, due to the passage through the ureter of masses of exudate, such as collections of fibrin, or pieces of kidney substance which have become disorganized and cast off, is sometimes present. Kidney and ureteral zones are both present. The kidney zone persists after the obstruction has been removed, while the ureteral zone disappears.

(2) *Renal Calculus.*--Here the pain comes on quite suddenly, and the ureteral zone and the kidney zone from the associated hydronephrosis are both present. When the obstruction is removed, and the dammed-up fluid escapes, the kidney and ureteral zones disappear simultaneously.

In pyelitis, pyonephrosis, and ureteral calculus an intermittent hydronephrosis occurs, and on bimanual examination the physical signs associated with it are found. Such signs are: (1) tumor, which is in the kidney region, and which increases in size during the period of colic, to rapidly decrease in size on the subsidence of the colic; (2) subjective pain in the back over the location of the kidney; (3) tenderness to deep pressure over the kidney region, the tenderness being especially well marked at the time of the hydronephrosis.

It is easy to understand how difficult it is definitely to decide from the pain complex the character of the kidney involvement, and the stage at which it rests. But with constant endeavor and close application in nearly all cases it is possible to do so. For a proper realization of the non-importance of their absence it must be recalled that disturbances in Head's zones are not constantly present, especially so should the attack under observation be only one of a series which has preceded it. During the preceding attacks the nerve filaments may have been destroyed to such an extent that subsequently they are not able to carry stimuli. Thus they are not able to respond to irritation. This is the reason why the Head zones are so often absent in parenchymatous involvement.

Pyelitis in Pregnancy.—Pyelitis is frequent in pregnant women, and is due to the pressure of the pregnant uterus upon the ureter, with a consequent stasis and infection of the urine. As a rule the infection comes from the adjacent colon.

In these cases pyonephrosis accompanies the pyelitis, and all the signs and symptoms usually associated with the former are present. However, inflammation of the renal pelvis itself does not cause pain unless there is a concomitant obstruction of the ureter by the pregnant uterus (Pilcher). To produce pain it is not necessary that the pyonephrosis be severe; in some cases a very slight distention will cause the most severe pain. A pelvis containing only one ounce of pus has been known to produce considerable pain. The reason for this is that the existing inflammation of the pelvis has penetrated to the parenchyma, and has caused it and the capsule to be more sensitive to stretching, and to react with pain production to a lesser threshold pressure than they would in their normal condition. The hydronephritic symptoms may be intermittent. They may disappear for a time only again to reappear with increased intensity.

Symptoms Associated with Pyelitis.—In pyelitis a careful examination of the urine is most essential to the making of a proper diagnosis. The presence of pus cells in the bladder urine is not of such special diagnostic import as are pus cells found in a specimen of urine catheterized from the ureter. Ureteral catheterization also gives a clear indication of the kidney which is involved. The temperature in pyelitis, as a rule, has a typical septic curve. In some cases the temperature curve is present for some days before the attack of pain. Chills are generally coincident with the paroxysmal pains. They are due to the absorption of septic material from the dammed-up urine.

Owing to the sympathetic relationship of the bladder and the kidney, secondary bladder symptoms, or rather preliminary bladder symptoms, since in nearly all cases they precede the other symptoms, are frequent. The symptoms especially associated with the bladder are frequency and difficulty of urination.

Pyonephrosis is an advanced type of pelvic inflammation in which a retention of urine from ureteral obstruction has taken place. In the very early stages of this condition the pain is not different from that present in the lesion from which the pyonephrosis originated. Later, pain typical of a hydronephrosis occurs. The inflammatory process now travels through the tubules into the parenchyma of the kidney and a general inflammation of the kidney structures ensues, the so-called pyelonephritis. However, a hydronephrosis does not always precede the formation of a pyonephrosis; the preceding condition may have been a pyelitis, without any accumulation of fluid in the renal pelvis. When pyelitis is present without pelvic distention, pain is absent, and only comes on when the pelvis of the kidney begins to dilate, and tension is made upon the kidney capsule, when a diffused, dull aching in the back is felt. At the same time disturbances in the kidney (Head) zones may become prominent, so that in many cases they are a sign of value. Should the disease still further progress and become extracapsular, tenderness to pressure is excessive; breathing becomes difficult, and motion of all kinds is greatly limited. At this time a perinephritis may develop. Urination becomes painful and frequent, and pain is referred to the glans penis and down the thigh (p. 609). The patient walks or reclines with the body bent toward the affected side, and in many cases the thighs slightly flexed on the abdomen. Pain may also be present on pressure anteriorly over the abdomen, and posteriorly over the flank; in some cases the anterior pressure may cause pain and the posterior pressure may give relief.

Symptoms associated with a pyonephrosis are:

(1) The presence of pus in the urine. It may be present only occasionally in intermittent pyonephrosis, being absent at the time the ureter from the diseased kidney is blocked, but appearing again as soon as the obstruction is removed. Its reappearance is concomitant with a greatly increased urinary flow. Pyelonephritis can often be diagnosed by the presence in the urine of casts composed of pus cells. It may be distinguished from pyonephrosis in that in the latter condition cellular casts are absent and large quantities of urine and pus are passed at intervals, at which time the symptoms referable to obstruction are relieved.

(2) Chills and fever, usually associated with a septic infection, are present.

Hydronephrosis.- *Causes.* Hydronephrosis is due to an obstruction of the ureter. It is of two types, constant and intermittent. Constant hydronephrosis is the result of forces acting constantly. Intermittent hydronephrosis is the result of some cause acting intermittently, and is due to the blocking of the ureter by a stone, blood clot, or piece of necrotic tissue.

Character of the Pain. Pain in hydronephrosis is not marked, except when the intranephritic tension is suddenly raised. Should the obstruction be complete pain at first is very severe, then gradually ceases, because, as a rule, under such circumstances the secretion of urine soon ceases and pelvic distention does not persist. The pain in the majority of cases of hydronephrosis is of a dragging or dull aching type, and may be continuous or intermittent. The intermittency indicates that the ureteral obstruction is not complete, and that at times there occurs a partial relief of the pressure from some of the urine being forced through the semipatulent canal.

Sudden and severe pain may occur if the hydronephritic sac should rupture into the abdominal cavity. Peritonitis then results and the pain assumes the character of the pain associated with that condition. It may radiate to the back above the pelvic brim, or around the side to the external genitals.

Sudden subsidence of the pain in hydronephrosis indicates that the obstruction to the onward flow of urine has been removed, either because it has been forced into the bladder, or because the material (calculus) which was acting as a valve at the entrance of the ureter has been forced back into the pelvis of the kidney, thus allowing the passage to be free (ball-valve action).

Associated Symptoms.—Associated signs of hydronephrosis are: (1) the presence of a tumor, located below the costal margin. It is round, smooth, or lobulated. The colon is anterior to it or is on its inner side; in this particular a tumor or enlargement of the kidney differs from that of the gall bladder, intestine, omentum, or appendix, which are generally anterior to the colon.

(2) Nausea and vomiting are very common in the cases of acute hydronephrosis.

Points that lead to an almost positive diagnosis of hydronephrosis are: (a) the presence of a dragging pain in the back, (b) a tumor mass in the kidney region, and (c) a decrease or increase in size of this tumor mass, occurring simultaneously with an increase or decrease in the amount of the urine, (d) ureteral catheterization and distention of the renal pelvis by measured quantities of salt solution, (e) injection of collargol into the renal pelvis, and then a Roentgen picture (these will clearly indicate the lesion).

Hydronephrosis in Pregnancy.—During pregnancy the uterus, because of unilateral enlargement, or because of its peculiar position in the pelvis, may make more pressure upon one than upon the other ureter. The consequence is that, if the pressure is great enough, a unilateral hydronephrosis results. This causes considerable annoyance to the patient and much anxiety to the attending physician, for, when the stasis occurs, violent pain, due to the increased tension in the pelvis of the affected kidney, is produced. Because of slight temperature, the presence of pus in the urine, the appearance of a mass which is tender in the lumboiliac region, and the constant complaint of the patient, a condition of this kind sometimes is mistaken for a lumbar or perinephritic abscess; yet the normal leukocyte count, the marked remission following a copious discharge of urine, the low position of the uterus, the relief which sometimes follows the assumption of the abdominal prone position, and the late stage of pregnancy, all point to a pressure hydronephrosis with a slight infection. After delivery the condition passes off without any permanent ill results.

A case illustrative of this condition is that of Mrs. M——, eight months pregnant, who at times would have severe pain on the right side in the kidney region. The pain would be accompanied by a lumbar enlargement on the same side. The pain and enlargement would both disappear synchronously with the appearance in the urine of a considerable number of pus cells. At the same time the quantity of urine would be greatly increased. After delivery all the symptoms disappeared.

Renal Calculus.— Renal calculi may lie in the pelvis of the kidney for many years without producing symptoms. Several cases have been reported where stones weighing as much as one ounce have remained quiescent in the kidney for long periods of time. In one case the presence of the stone was entirely unknown to the patient until an abscess formed and ruptured posteriorly. If these stones do not at times produce symptoms it is necessary to know what must occur before their presence becomes so intolerable as to draw attention to them.

Etiology of Calculus Pain.—From a long series of observations it has been concluded that renal calculi do not produce pain symptoms unless a blocking of the ureter occurs.

For a long time and by many observers it has been held that a spasm of the ureter is the cause of pain in calculus colic, and it has only recently been determined that the pain of renal calculus is not due to spasm of the ureter, but is caused by tension on the renal capsule from back pressure of the urine. Many cases confirmative of this could be cited, but Bevan's case, which is described on page 605, will illustrate the point exactly. Fenwick, in 1893, was one of the first to suggest this explanation of a calculus colic.

That the distention of the ureter is not the only cause of renal calculus pain, and that the ureter itself has some place in the pain production, is seen in the changing position of the pain as the

DIFFERENTIAL DIAGNOSIS—HYDRONEPHROSIS

SYMPTOMS	HYDRONEPHROSIS	OVARIAN CYST	MOVABLE GALL BLADDER
Pain.	Constant where the ureteral obstruction is permanent. Intermittent where the ureteral obstruction is irregular.	Generally but little pain.	Pain is in the gall-bladder areas (q. v.). This pain can be produced by pressure on or by traction dragging on the tumor mass.
Tumor.	Is to one side of the vertebral column, and extends laterally into the lumbar region.	Is more central. Arises out of the pelvis. Tympany of the intestines lies above and lateral to it.	Is on the right side. Rotates around a center located near the margin of the right tenth costal cartilage.
Colon.	Lies in front of a hydronephrosis, though in those of very large size it may lie to the inner side.	The colon lies posterior to or above the tumor.	No special relationship to tumor mass.
Uterus.	Is very freely movable, and has no connection with the tumor.	Generally attached to the tumor by means of adhesions.	May be entirely normal.
Urine.	Intermittent polyuria may be present.	No urinary change.	No urinary change.

stone gradually progresses downward toward the bladder. The cause of this changing pain is the progressive distention of the ureter proximal to the stone, for, as the stone advances, the dilatation progresses downward and the pain likewise becomes lower until it merges into that due to bladder involvement. The reason that the passage of some calculi is painful and that of others is not is that those which are not painful as a rule are small, and do not block the ureter to as great a degree as do the larger ones. A stone that is sharp also may cause considerable irritation and consequent inflammation of the mucous membrane, and thus block the ureter, and give rise to greater pain than a smooth stone of much larger diameter. Oxalate of lime calculi are rough, hard, spiculated, and nodulated, and are more painful than the uric acid stones, which are smooth.

The blocking of the ureter may be due to the calculus itself or may be the result of the lodgment in the ureter of clots or of fragments of débris, the consequence either of hemorrhage or of infection secondary to the calculus formation. If the obstruction of the ureter is acute and complete, pain, which at first was a prominent symptom, gradually becomes less marked and finally disappears. This disappearance is accounted for by the slowly progressive decrease in the urinary secretion, so that the pressure in the renal pelvis, which at first was excessive, becomes less and less, and finally is entirely absent. If in any stage of this process the back pressure urine should be infected, or should infection occur later, when the fluid in the renal pelvis has been absorbed, a new factor in the pain production makes its appearance. For this infection causes irritation to the kidney cells, pus again accumulates in the renal pelvis, pressure is again exerted, and pain once more appears.

This *secondary pain* is of a serious prognostic import. It tells the tale of progressive kidney disaster, for as soon as pus invades the parenchyma of the kidney, and a kidney abscess with marked sensory disturbances in Head zones appears, it indicates further spread of the infection, on its evil march of progress. It now soon extends to the perirenal tissues, and forms a perirenal abscess.

From this arises the last set of symptoms of this grave disorder. For a description of these symptoms see Perinephritis.

Character of Calculus Pain.—In nearly every case of renal calculus pain is present at some time in its course. This pain may be either constant or paroxysmal. The more or less constant pain is present when the stone is in the renal pelvis and is too large to enter the ureter. Because of its position it may have a ball-valve action, and unless the inflammation is more or less severe, the pain is not constant, so that when the pain does become constant it indicates that inflammation of the renal pelvis has occurred.

The paroxysmal pain complained of, as a rule, is very sudden in onset and is unilateral. It is mostly on the side of the affected kidney, but has been known to be present on the opposite side (reno-renal reflex). It is present in half the cases of renal calculi, and is of the greatest severity. In fact, it may be so severe that the patient, under its influence, becomes irrational and demoniacal.

At first it is more of an intermittent or constant aching or dragging in the small of the back. This at times is interrupted and aggravated by twitches of pain, until suddenly some day an attack of the greatest intensity occurs. The pain now switches from the back, and may run around the crest of the ilium to the anterior abdominal wall, and be located beneath the ribs or in the iliac region. It may also be felt in the groin or in the testicle of the affected side, following the course of the genitocrural, the ilioinguinal and the iliohypogastric nerves. It may even be felt in the leg in the course of the lumbar nerves, and, though it may go as far as the toe (anterior-crural), it rarely runs farther than the knees. The testicle during an attack is painful and sore. It is said by Head that retraction of the testicle takes place as soon as the stone reaches a point above the pelvis. The scrotum is not affected. The reason of this is that originally the testicle was an intraabdominal organ, arising at about the same visceral level as the kidney. It gradually became more and more displaced downward, until it reached its present position. As it descended it carried with it some of its coverings and its own nerve supply; this nerve supply arises from the same cord segment as do the nerves supplying the kidney and upper part of the ureter. Consequently any lesion in the kidney may reflexly cause pain to be experienced in the testicle. The scrotum is not affected because it derives its nervous supply from a different set of nerves which are not in any way intimately related to those supplying the kidney or ureter.

Duration of the Attack.—The duration of the attack is variable. It may last only for a few minutes or for as many hours. Generally it lasts until the stone has either been forced back into the kidney pelvis, has entered the bladder, or until dilatation of the ureter has taken place, so that the urine can pass around the stone. As the stone approaches the bladder, frequent and painful urination occurs. When the condition has persisted for some days exacerbations of pain are frequent at night, and are probably due to pressure on the kidney by gas passing down the bowel (Jackson). Attacks of pain may at times be caused by an overloaded colon. They may also occur spontaneously or be due to mechanical means, such as jarring or vibratory movements. Manipulation of the kidney also incites an attack. Sudden cessation of the pain generally indicates that the stone has passed through the ureter into the bladder.

Location of the Pain.—In renal calculus there are three varieties of pain: (1) local pain, (2) referred pain, and (3) reflected pain.

In the renal calculus disorders, the local pain, as a factor in diagnosis, can practically be disregarded. It is not present, except in the form of tenderness, which will be considered later.

Referred pain is the name given to the pain which is transmitted along the course of the spinal nerves from an irritation on one of their branches. Here is, indeed, a hornet's nest, for it is almost impossible, in this connection, to differentiate the referred from the reflected pains, inasmuch as both are transmitted along the same nerve fibers, though each has a slightly different

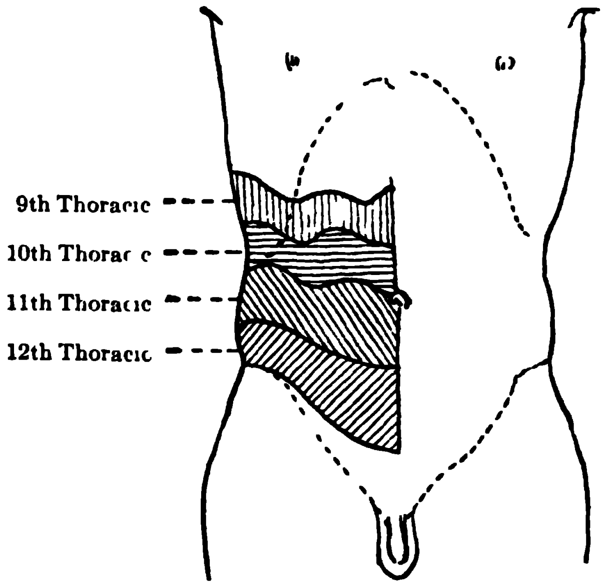


FIG. 150—AREAS OF DISTRIBUTION OF ANTERIOR SPINAL NERVES In these areas the pain of kidney lesions is sometimes referred

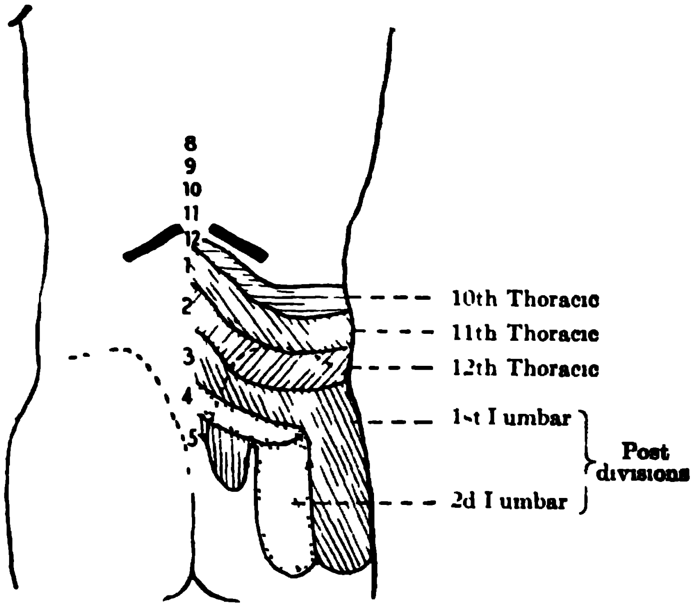


FIG. 151—AREAS OF DISTRIBUTION OF POSTERIOR SPINAL NERVES In these areas the pain of kidney lesions is sometimes referred.

distribution area. Yet it is not of absolute importance, as far as diagnosis is concerned, to differentiate between the two.

Below will be shown the distribution area of the spinal nerves; and at the same time the distribution area of the zones of Head, which represent the *reflected* pain. The reno-renal reflex also represents a reflected pain.

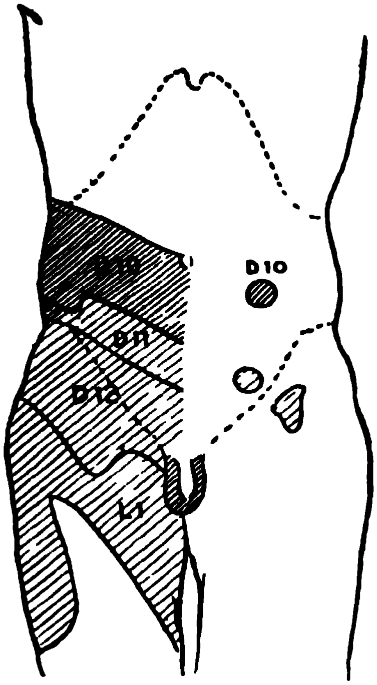


FIG. 152.—HEAD ZONES OF HYPERALGESIA USUALLY ASSOCIATED WITH KIDNEY LESIONS ANTERIOR VIEW.

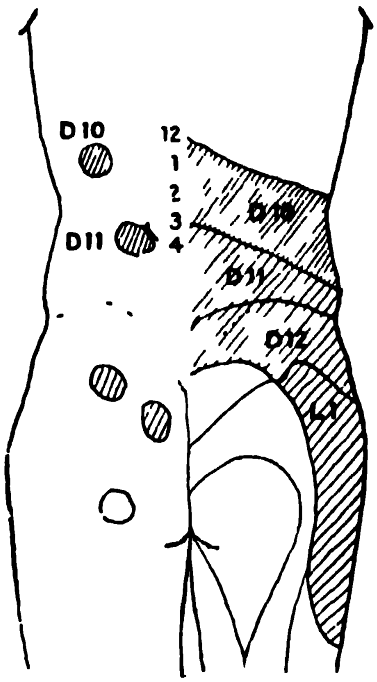


FIG. 153 HEAD ZONES OF HYPERALGESIA USUALLY ASSOCIATED WITH KIDNEY LESIONS POSTERIOR VIEW

Figures 150 and 151 show the areas of distribution of the cerebrospinal nerves, figures 152 and 153 show the area of distribution of the cord zones.

From the accompanying figures it may be seen how closely the distribution of the spinal zones corresponds with the distribution area of the spinal nerves. As the calculus progresses down the ureter, these areas of hyperalgesia extend lower and lower (from the tenth dorsal to the first lumbar), so that in some cases the progress of the stone may be defined by the progressively lower location of the hyperalgesic areas. The circles which are shaded indicate the maximal points of tenderness of the respective zones. When the colic comes on and ureteral dilatation occurs, these areas of maximal pain are most exquisitely tender, and by the uninitiated are often mistaken for tenderness in an underlying organ.

The following drawing is from Head, and the accompanying legend will sufficiently explain it.

Reno-renal Reflex. In some cases of renal calculus the pain may be reflected entirely to the opposite side. Although there has been much controversy in regard to this condition, there can be no doubt that this so-called reno-renal reflex is occasionally present. In it pain may apparently be associated with one kidney which is entirely healthy, while the other kidney is diseased. Mr. Morris does not believe in its presence, and in his work, "Surgical Diseases of the Kidney and Ureter," says that "this theory is unsound and dangerous if acted upon"; but Maylard quotes a case of his own, confirmative of it, namely: A man, aged 28, complained of a "nagging pain in the right iliac region, which seemed to him to pass upward and lodge in the right iliac lumbar

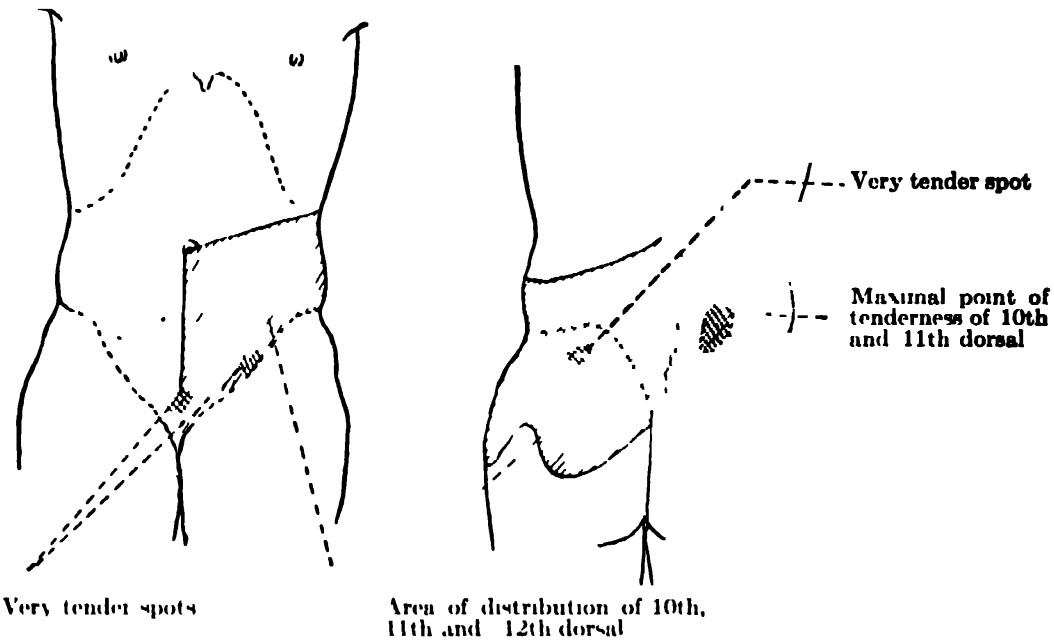

Very tender spot
Maximal point of tenderness of 10th and 11th dorsal
Very tender spots
Area of distribution of 10th, 11th and 12th dorsal

FIG. 154. AREA OF CUTANEOUS HYPERALGESIA IN SEVERE RENAL COLIC IN WHICH THE STONE WAS IN THE URETER. "The pain starts behind at the tip of the twelfth rib and runs forward to a point in the left iliac fossa, thence to a point above the internal ring, then to the pubes, and thence to the inner aspect of thigh where it ends just above the knee." (Head, Brain, Vol. XVI, p. 76.)

region, where it produced a dull, sickening sensation. It would linger there for twenty-four hours, during which time he would vomit. Urine, after one of these attacks, contained albumin and red blood cells, but not tube casts. Maylard explored the right kidney and passed a catheter down the right ureter, but nothing could be detected. Suppression of urine developed immediately after operation, and the patient died on the fourth day. On post mortem the right kidney was perfectly healthy, but the left one contained in one of the upper calices a calculus about as large as a pea." (Maylard, "Abdominal Pain," p. 101.) Other cases, too numerous to mention, confirmative of this condition could be cited. Prout, in 1840, was probably the first to draw attention to this reflex.

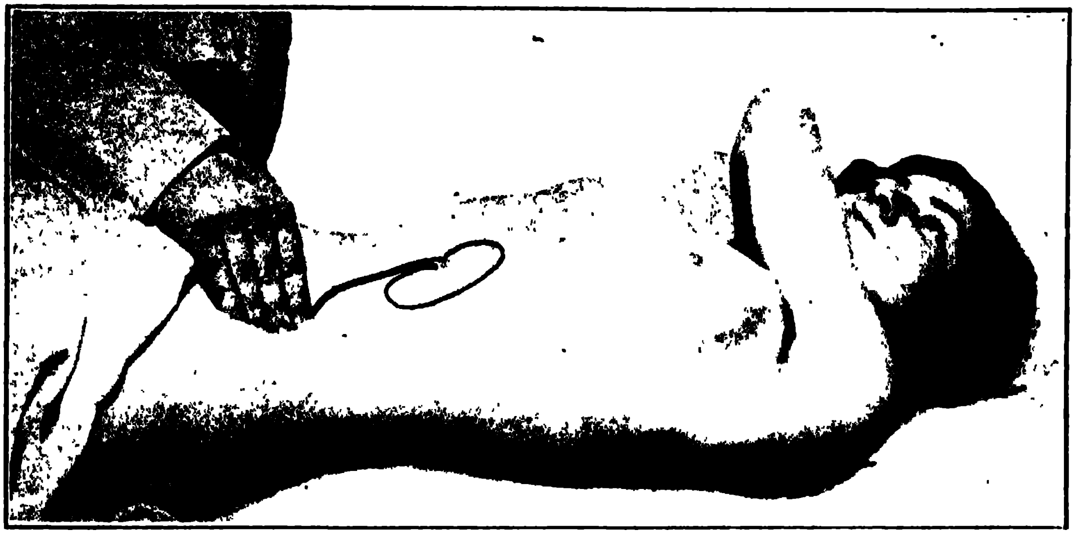


FIG. 155.—PRESSURE MADE UPON URETER IN ENDEAVOR TO OBTAIN LOCAL TENDERNESS. The pressure is made directly over the region where the ureter passes over the pelvic brim and enters the cavity of the pelvis.

Therefore, in all kidney cases it is most necessary, in order that mistakes may not be made, that this peculiar and unusual transference of the symptoms be considered. Many a tragedy of surgery has occurred because the surgeon was ignorant of this phenomenon. Its manner of occurrence is explained under the description of the reflection of kidney pain. In all cases of suspected kidney disorder the attending physician and, most of all, the surgeon, should not rely too much upon the character of the symptoms to define the kidney affected. In every case one always has the ureteral catheter with which to collect a little urine, and thus possesses the means definitely to localize the lesion.

At times it is very difficult, from the pain phenomena alone, to localize the stone to a certain definite part of the ureter, for occasionally a stone in the lower end of the ureter will produce pain in the kidney area, while one in the upper part of the ureter or in the pelvis of the kidney will produce pain along the entire distribution area the zones associated with the ureter.

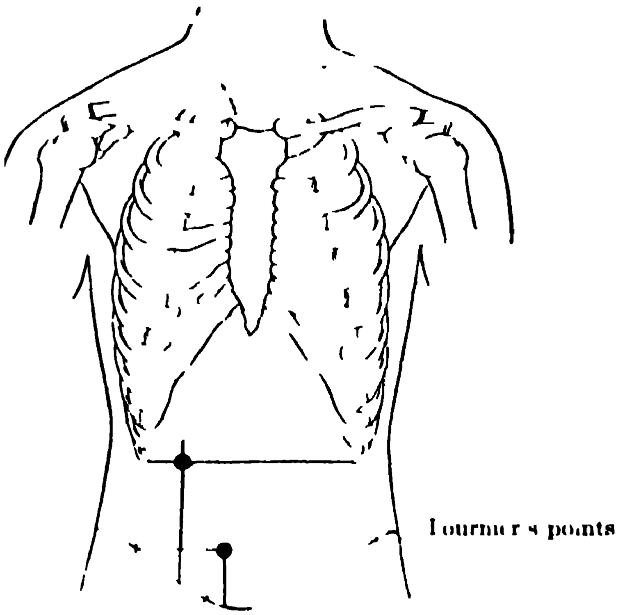


FIG. 156. TOURNIER'S POINTS OF PRESSURE IN KIDNEY AND URETER LESIONS

Tenderness. Tenderness is always present in calculus disease. It may be of the superficial type found in the maximal points of tenderness of the Head zones, or it may be the local tenderness found over the affected kidney (anterior or posterior) or along the course of the ureter.

The upper part of the ureter and the lower extremity of the kidney approximately may be reached by pressure at the level of a point described by Tournier as being "situated at the intersection of a transverse line drawn between the tips of the twelfth ribs with that of a vertical line drawn upward from the junction of the inner and middle thirds of Poupart's ligament."

Tenderness at this point indicates a painful lesion of the ureter, such as is produced by ureteritis, tuberculosis, or calculus. The intersection of a line drawn between the two iliac spines with one that is drawn vertically through the spines of the os pubis approximately indicates the point at which the ureter passes over the pelvic brim. Because of the narrowed lumen of the ureter at this point a calculus frequently lodges here and causes pain.

Palpation of the ureter is not very satisfactory. In men it may be palpated for one or two inches above the bladder by a rectal examination, while in women, by a vaginal examination, it may be palpated for two or three inches above its vesical insertion. In this lower accessible portion, therefore, local tenderness in cases of stone or inflammation may be elicited by palpation. The great difficulty in drawing conclusions from tenderness located in this region is that it is almost impossible to say with any degree of positiveness whether the tenderness which is present, is due to ureteral involvement alone or is the result of some disease of the adjacent structures.

Factors Influencing the Pain. - The factors influencing the painful attacks are:

(1) *The Position of the Patient.* Change of position sometimes causes pain, and certain positions are productive of more pain than are others. These positions are generally the ones in which the stone, if present in the kidney, would have a tendency to gravitate to and block up the outlet of the renal pelvis. In these cases the pain is the result of pelvic distention. Reversal of the position which produced the pain generally eases it, and may even cause it to disappear entirely, the disappearance being followed by a considerable increase in the flow of urine. Should the stone be in the ureter change of position would not produce any special difference in the amount of pain produced unless the changed position should cause pressure, pulling or dragging upon the ureter by some of the adjacent organs.

On the other hand, should the kidney be movable, and displacement occur, it is easy to conceive how, in the dropping or in the turning of the kidney from the displacement, a kink or a twist may occur in the ureter, and how this, by causing renal distention, may act as a pain-producing factor. Under these circumstances a replacement of the kidney into its normal location will relieve the pain.

The patient, during an attack of renal colic, generally lies all bent up. At the same time he, as a rule, presses his hand into the abdomen, and this seems to ease the pain. In this, renal colic is not different from other colics, for all are to some extent relieved by pressure. Patients affected with kidney calculus walk with the hand so placed over the affected side that the thumb presses on the loins behind and the fingers on the iliac fossa in front. (See Figure 112, p. 617.)

(2) *Motion.*—In those who have kidney stones motion often incites an attack, especially so when the motion is similar to that which occurs in riding over rough roads in a badly constructed carriage, or in vehicles in which there is considerable jolting, that is, one may say, shaking motion. Lifting, sudden, sharp turning, as in tennis playing, throwing, running or jumping, all seem to initiate an attack. Bending forward or backward is apt to cause its appearance, or to increase it if it is already present.

(3) *Digestion* seems to be especially potent in causing pain in renal calculus. This is probably due to two causes: (a) the changing relationships of the bowel during digestion cause it to press upon the kidney and thus produce pain, and (b) the disturbed digestive powers of the alimentary tract may cause some substances to be absorbed, which, on being eliminated, increase the irritability of the urine and give rise to pain as they pass over the sensitive mucous membrane lining of the kidney and ureter.

(4) *Manipulation* of the kidney frequently incites an attack of renal colic.

Associated Symptoms. Symptoms associated with the passage of a renal calculus are:

(1) *Frequency of Micturition.*—This becomes more annoying the nearer the stone is to the bladder until, when it is just external to the bladder, the desire to urinate is almost constant. According to Schmidt, the opposite holds true in tuberculosis of

the kidney without a cystitis, and in kidney infarct, when the desire to urinate almost entirely disappears.

(2) *Increased Blood Pressure.*—The blood pressure is greatly increased at the time of the attack, but this is only a vasomotor reflex incited by the pain sensation. It is nothing more than the usual reflex associated with all severe pain. It but confirms the patient's statements that pain is present.

(3) *Swelling and sensitiveness of the urethra* may precede an attack.

(4) *Digestive Symptoms.*—Nausea may be present and vomiting is very common. Both may be present without the pain. They are due to the close association of the kidney, intestines, and stomach, through the abdominal sympathetic. These digestive disorders, when severe, may lead to error in diagnosis, especially so when constipation is present.

(5) *Changes in the Urine.*—(a) Blood as a rule is present. It follows an attack of colic. While appreciable microscopically, as a rule it is not in any very great quantity. (b) Various urinary salts, as phosphates, urates, oxalates, are present in abnormal amounts. (c) Albumin may be found. (d) The sign of great value is the absence of the normal urinary flow from the ureter on the affected side. This can best be demonstrated by the use of the cystoscope and ureteral catheter.

(6) *Subjective sensations of cold* in the thigh of the affected side are sometimes present (Schmidt).

(7) *Chills* are very frequent, especially when Dietl's crisis is present.

(8) *Spasms* in the muscles of the calf or thigh of the same side may be present (see Innervation).

(9) *Collapse* may occur at the time of the greatest severity of the renal pain.

(10) *Elevation of temperature* is frequent at the time of the attack.

(11) *Renal Stones.*—The X-ray, as a rule, shows a renal stone.

In many instances, while the colic may indirectly be due to calculus formation, it is not directly so produced; for instead of a calculus the obstruction to the ureter has in many instances been found to be pieces of blood clot, etc. Generally they are the result of a secondary infection.

Differential Diagnosis. The diagnosis of a renal calculus should be made from tuberculous kidney, new growth of the kidney with hemorrhage into the substance, and kinks of the ureter. In renal calculus the colic is sometimes mistaken for that of intestinal obstruction, chiefly on account of the intestinal distention and the inability to move the bowels. These latter are frequently the result of the large doses of morphin which have been given to the patient. Ureteral colic on the right side is often confused with appendicitis.

DIFFERENTIAL DIAGNOSIS—RENAL LESIONS

SYMPTOMS	RENAL T. B.	HYDRONEPHROSIS	RENAL CALCULUS	PERINEPHRITIS
Pain.	Generally very little in the early stages, and the pain that is present is due to a nephrectasis or to a spreading of the disease to such an extent that either the entire parenchyma or the perinephritic tissues have become involved.	Considerable pain is present, especially so if the condition is one of acute origin. Generally the pain felt is due to the original cause of the disease.	There may be no pain as long as the calculi remain in the pelvis of the kidney. Pain is felt only when the stone passes into the ureter. Then symptoms of ureteral colic, sudden, sharp, paroxysmal, agonizing pains occur. The pain is the most severe to which man is heir. The severity is due to the very sharp and jagged character of the calculus.	Generally rather severe at first. A general aching, and tenderness to deep pressure. Then, later, there is present a tumor with great pain and excessive tenderness.
Urine.	Generally turbid. Specific gravity is low. Blood frequent though not profuse. T. B. are present in the centrifugalized urine. Inoculation produces death in the guinea pig.	Generally but slightly changed. Blood is frequently profuse after relief of the occlusion. Sudden increase in the quantity of the urine causes a diminution in the size of the tumor.	Generally a diminution at the time of the colic followed by a sudden increase on the relief of the colic.	May be no very great change in the character of the urine, though, as a rule, some red cells or leukocytes are found.
Fever.	Generally not present unless secondary infection, with pus-forming bacilli, occurs.	Absent in the majority of cases.	Generally absent.	Generally absent.
Tumor and catheterization and tenderness.	Early formation. On catheterization, no noticeable difference in size of the tumor mass may be found. Tumor not tender.	Immediate formation. Decreased in size on ureteral catheterization of the pelvis. Tumor can be produced at will by filling the pelvis of the kidney with fluid. Idem.	Tumor may or may not be present. When it is present, it is due to a hydronephrosis. Passage of a wax-tipped catheter shows location of stone. Idem.	Tumor present some time after the development of the pain. Size of tumor not affected by renal catheterization. Very tender.

CHAPTER XXX

THE URETER, BLADDER AND URETHRA

THE URETER

Pain associated with ureteral involvement is due to:

(1) Obstruction of the ureter. This is caused by muscular spasm, which produces (a) hydronephrosis, in which there is generally a certain amount of associated infection, and (b) dilatation of the ureter. Obstruction may also be caused by calculus, blood clots, detritus, kinks, external pressure from tumors (aortic aneurysm) or growths in adjacent organs (as carcinoma of the bladder at the point of ureteral insertion), displacement of adjacent organs (making pressure on the ureter), and stenosis of the ureter, which may be intralumenary from stricture, or extralumenary from inflammation of the walls or of the surrounding tissues.

(2) Inflammation (ureteritis) may also cause pain in ureteral disease.

Obstruction to the ureter produces at first a muscular spasm and then a distention of the proximal ureter and renal pelvis. This causes a sudden sharp pain. To what extent the ureters are innervated by the cerebrospinal system is still a question for the physiologists, but it has been shown that the mucous and muscular coats are innervated by both medullated and non-medullated nerves, so that the spasm, which is produced by an irritating stone, would affect both cerebrospinal and sympathetic nerves, and thus cause both local and reflected pain. The local pain is due to the irritation of the cerebrospinal nerves, and the reflected pain is the result of irritation to the sympathetic nervous system. Later, should inflammation ensue and the outer coat of the ureter be involved, the local is more prominent than the reflected pain; and if the adjacent tissues are affected the local pain far outshadows the reflected. Generally, however, such fine distinctions cannot be made in practice, yet if it were possible to follow a case of ureteral stone colic from its incipiency to its conclusion, such a transgression from reflected to local pain might sometimes be found, and the presence or absence of inflammation exactly defined. This is easier if the obstruction is incomplete, but at the same time sufficiently irritative to cause inflammatory reaction.

According to Ashton, "When the ureter is inflamed pain is elicited at the brim of the pelvis, about one to one and one-quarter inches on either side of the promontory of the sacrum, and over the upper or renal portion by deep palpation." (See Fig. 155.)

A reference pain due to stone in the ureter which would seem to be of value is given by Bennett. In this case a stone lodged in the vesical end of the right ureter, and caused more or less constant *pain in the right groin.* The pain was never acute and rarely was entirely absent. It was worse in the morning on leaving the bed, and again in the evening. Possibly a little increase of the pain was noted when the bladder was full. On removal of the stone the pain ceased (Bennett). According to Howell (287, p. 445) the pain in renal colic is felt at a point a little below the ninth costal cartilage in the mid-clavicular line, from which it runs downward to the testicle and along the inner side of the thigh, following the cutaneous distribution of the eleventh and twelfth dorsal and the first lumbar nerves.

Should obstruction be complete the pain of distention occurs *pari passu* with that of the spasm. The distention of the renal pelvis first occurs, and therefore the first organ to be affected by the distention is the kidney. It reacts to it and causes a sense of aching, tenderness, and pain in the lumbar region.

Tumors of the ureter as a rule are not painful unless they cause a sudden obstruction to the ureter, either from pressure, or from inflammatory swelling due to an acute infection. They may also cause pain by the pressure of the ureteral mass upon the surrounding structures. Depending upon the location of the mass, either local or referred pain, or both, may be produced.

Piersol ("Anatomy," first ed., p. 1914) gives a good idea of the route of pain reference in kidney, ureter, and bladder diseases. He says: "The skin of the scrotum and penis is supplied with sensation from the same spinal segments as is the bladder, and therefore the referred pain in vesical irritation or inflammation is often felt in those regions in the distribution of the perineal branches of the pudic and the inferior gluteal nerves. The tickling or itching around the anus, or painful contraction of the sphincter, which may be present, is the referred sensation through the inferior hemorrhoidal nerve from the sacral plexus. Lumbosacral pain is felt through the communications between the second, third, and fourth sacral nerves and the hypogastric plexus. Pains in the area usually associated with the kidney disease are due to the junction in the spermatic plexus of filaments from both the renal and the vesical plexuses. Pain over the kidney region may also be due to the involvement of the spinal nerves. Pains in the lower limbs, especially in the foot (pododynia), are produced by the irritation carried through the sacral nerves into the sacral plexus and the lumbosacral cord, which give off the great sciatic nerve."

THE BLADDER

GENERAL CONSIDERATIONS

Anatomy. The bladder is next to the last division of the urinary apparatus, and acts as a reservoir for the urine. It is very loosely attached to the surrounding structures, and can be subjected to great distention before it causes inconvenience to, or pressure on, adjacent organs; but when it is so distended pain and discomfort are most marked. The urinary bladder is unlike most other abdominal viscera because of its great distensibility (in this it resembles the stomach), and its peculiar position (being almost extraperitoneal) and because its cavity is in almost direct contact with the external air.

Because of this contact the bladder is much more susceptible to inflammatory diseases than are the abdominal viscera, which are entirely intraperitoneal.

Nerve Supply.—The nerve supply to the bladder, being both sympathetic and spinal, grants to it attributes possessed by both these systems. The sympathetic system keeps it in harmony with the abdominal viscera, while the spinal system supplies its muscular coats and acts as a finely sensitized apparatus which quickly responds to all harmful irritations giving rise to the sense of pain. The sympathetic nerves are distributed principally to the muscular coat. They follow the arteries and are derived from the vesical plexi, which, in turn, arise from the pelvic plexi (Piersol). When the sympathetic fibers are irritated the stimulus is carried to the cord, and thence is reflected to the body wall, where it *may* be felt as pain. When the *spinal* nerve filaments are irritated the pain is referred to the region of the bladder, although its exact localization is rather indefinite. The *sympathetic* nerve supply differs from the *spinal* in that, although deep pressure pain perception is carried through its fibers, it also carries stimuli to the cord, from which they are referred as pain to the cutaneous areas having their nerve supply derived from the same segment.

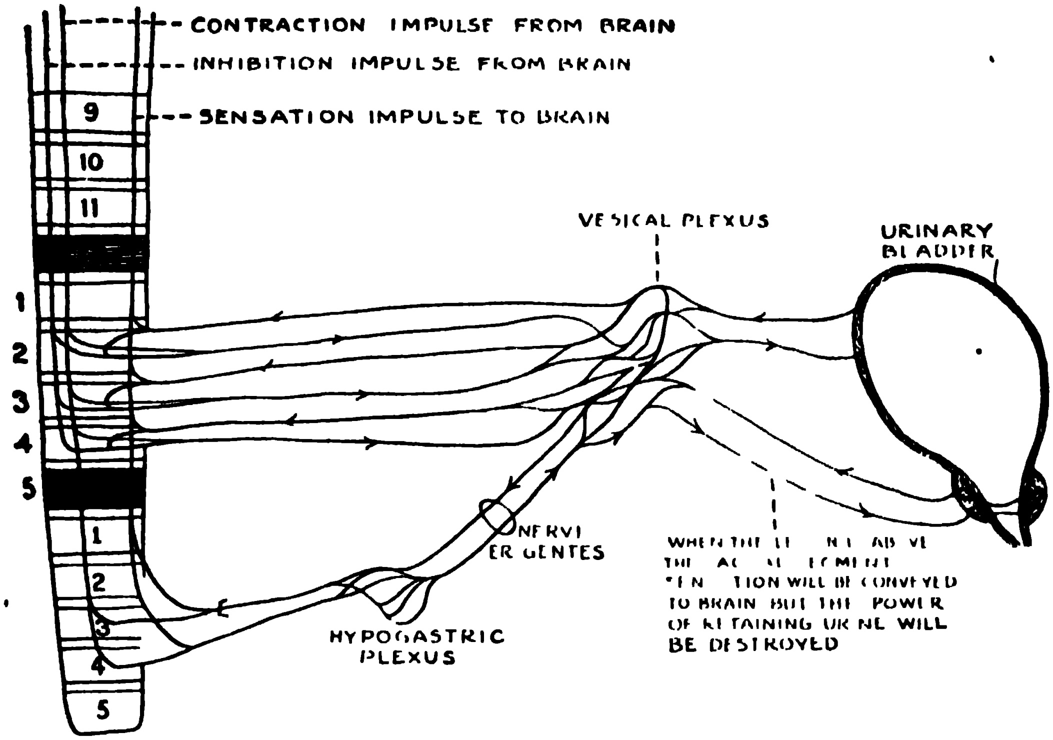

CONTRACTION IMPULSE FROM BRAIN
INHIBITION IMPULSE FROM BRAIN
SENSATION IMPULSE TO BRAIN
9
10
11
1
2
3
4
5
1
2
3
4
5
VESICAL PLEXUS
URINARY BLADDER
NERVI ERIGENTES
HYPOGASTRIC PLEXUS
WHEN THE LESION IS ABOVE THE SACRAL SEGMENT SENSATION WILL BE CONVEYED TO BRAIN BUT THE POWER OF RETAINING URINE WILL BE DESTROYED

FIG. 157.—RELATIONSHIP EXISTING BETWEEN PAIN AND OTHER SENSATIONS ARISING IN THE URINARY BLADDER.

The sympathetic fibers are derived principally from the *vesical plexus,* which is in direct communication with the second, third, and fourth lumbar segments of the cord, and it is through these communications that motor impulses are carried to the bladder wall. The vesical plexus communicates with the hypogastric plexus, which, in turn, communicates with the second, third, and fourth sacral nerves. This supply is sensory, as can be seen from the diagram.

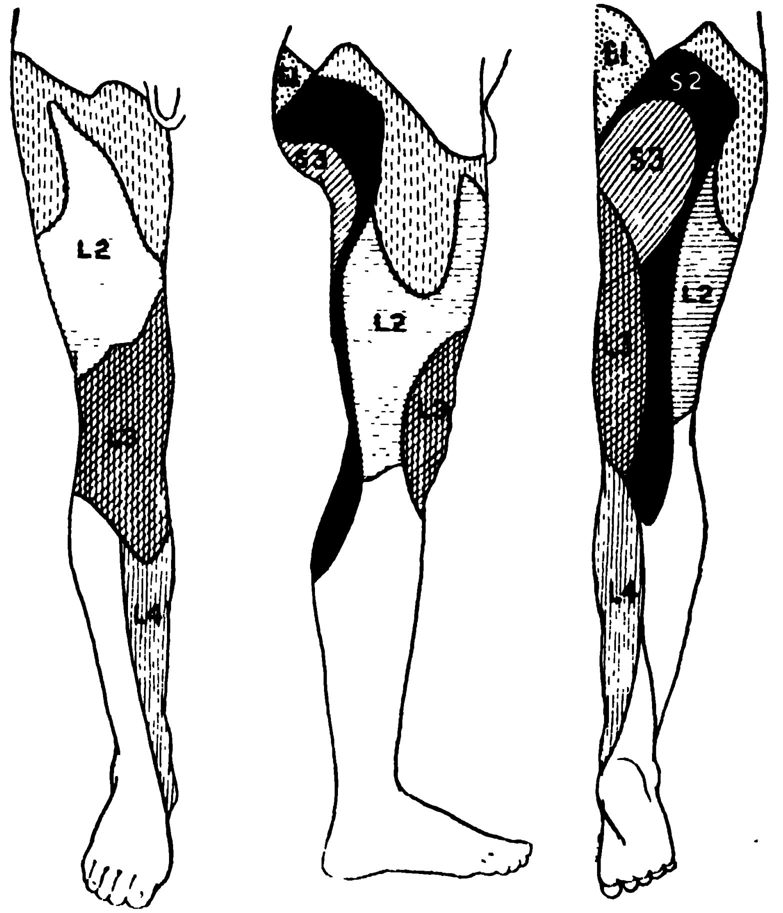


FIG. 158.—PAIN AREAS ASSOCIATED WITH DISEASES OF BLADDER. (According to Head.)
The 2d, 3d and 4th sacral areas are the ones in which the bladder pains are usually referred.

That the pain sensation is carried through the nerve fibers which are derived from the sacral segments is apparent, because, in a lesion of the twelfth dorsal segment, ordinary sensations from the bladder are lost; but if the lesion is below the first and second sacral segments sensation is not lost.

The *cord zones,* in relationship with the bladder; are given above. These are not so useful in the defining of bladder lesions, because the intensity of the pain from almost every painful lesion of the bladder is so great that it overwhelms the localizing sense, so that it is almost impossible to define the zonal areas. The areas most commonly affected in bladder lesions are the second and third, and possibly the fourth sacral. It is possible also that sensation may be referred through the second, third and fourth lumbar nerves, though such a reference is very unusual. That it may occur is certain, as is maintained by Head, who says that "in those cases where there is distention of the bladder, and ineffectual attempts are made by the patient to evacuate, the pain is of a sharp, shooting character, radiating from the lower lumbar and sacral regions behind, around the ilium to the lower part of the abdomen just above the pubes, and also down the inner side of the thigh to the knee." The pain may also extend to the outer side of the thigh.

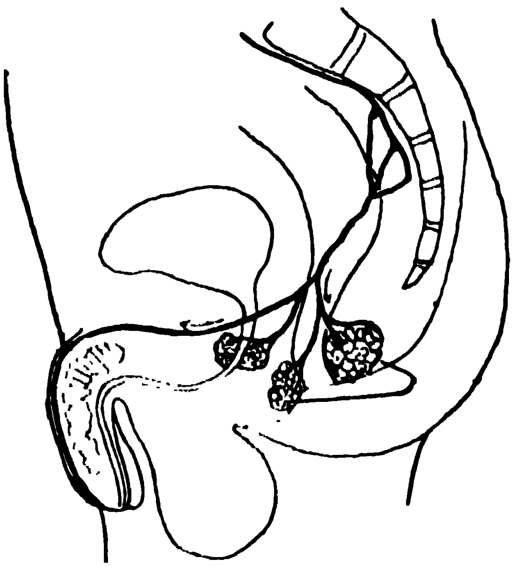


FIG. 159. RELATIONSHIP OF RECTAL TENESMUS TO VESICAL TENESMUS. The transmission is through the pudic nerve which also supplies the prostate and the glans penis. When any of these regions are affected it is common to have pain referred to any one, or all three, of the three regions.

The accompanying drawing (Fig. 159) illustrates the relationship of rectal tenesmus to vesical tenesmus and the method of reference of bladder pain into the penis.

The reference areas of bladder pains have been nicely illustrated in Figure 160, which represents the pain of cystitis, following instrumental crushing for the removal of stone. These drawings, which were taken from Head ("Brain," Vol. 16, p. 82), represent points of maximal tenderness, which were found, (1) over the ischial tuberosity, (2) over the lower part of the sacrum, and (3) over the tip of the glans penis.

Causes of Pain.—All direct bladder pains are, of course, due to irritation of sensitive spinal nerve filaments in the bladder walls. Some of the indirect pains are due to pressure, dragging or pulling upon the adjacent perivesicular structures. Generally lesions of the bladder proper are not painful unless they encroach directly upon the trigone, for this is the only part of the bladder which is

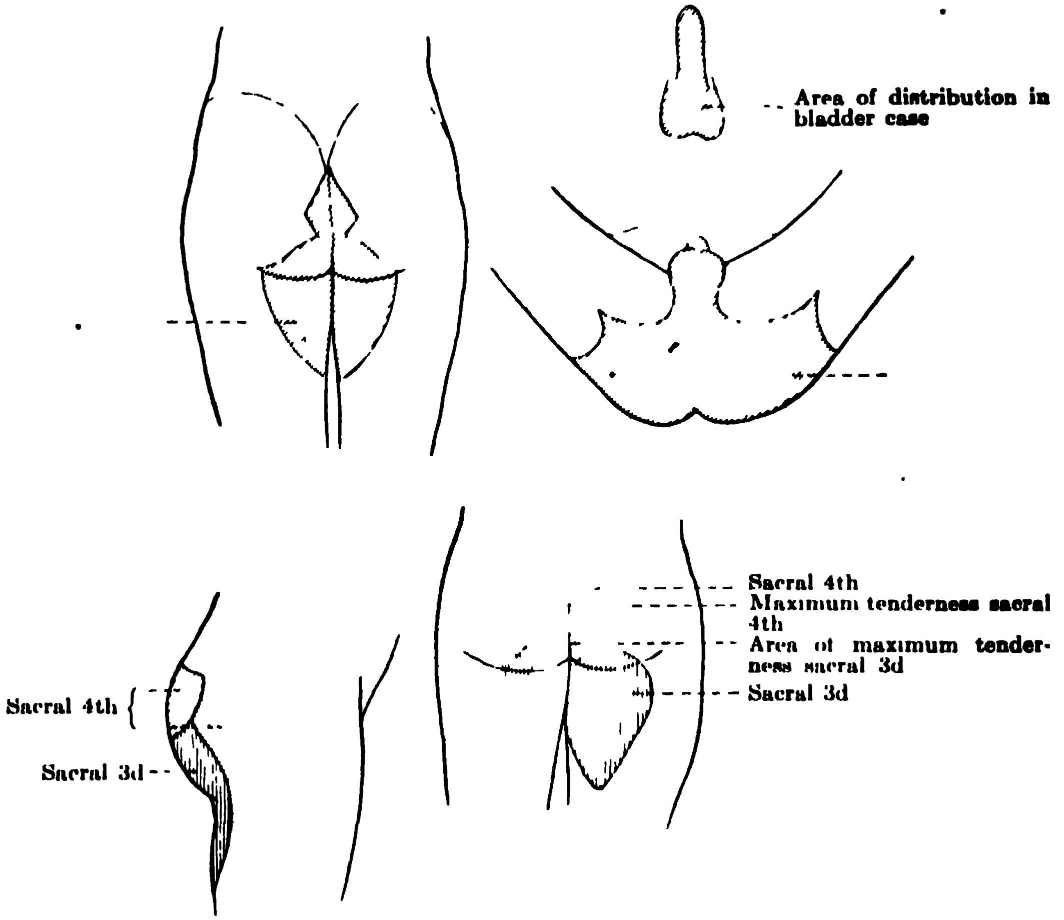

Area of distribution in bladder case
Sacral 4th
Sacral 3d
Sacral 4th
Maximum tenderness sacral 4th
Area of maximum tenderness sacral 3d
Sacral 3d

FIG. 160. - AREAS OF REFERRED PAINS USUALLY ASSOCIATED WITH DISEASE OF URINARY BLADDER. (According to Head.)

extremely sensitive. Even in the absence of inflammation, touching of it by a sound or probe is provocative of the most intense distress. How much more this distress is increased when the membrane is inflamed can easily be surmised. If it is inflamed, and there is also increased irritation associated with a sharp and jagged calculus, it is apparent that every time the bladder walls contract a sharp and agonizing pain is bound to result. If adhesions exist between the bladder and adjacent organs, pulling and

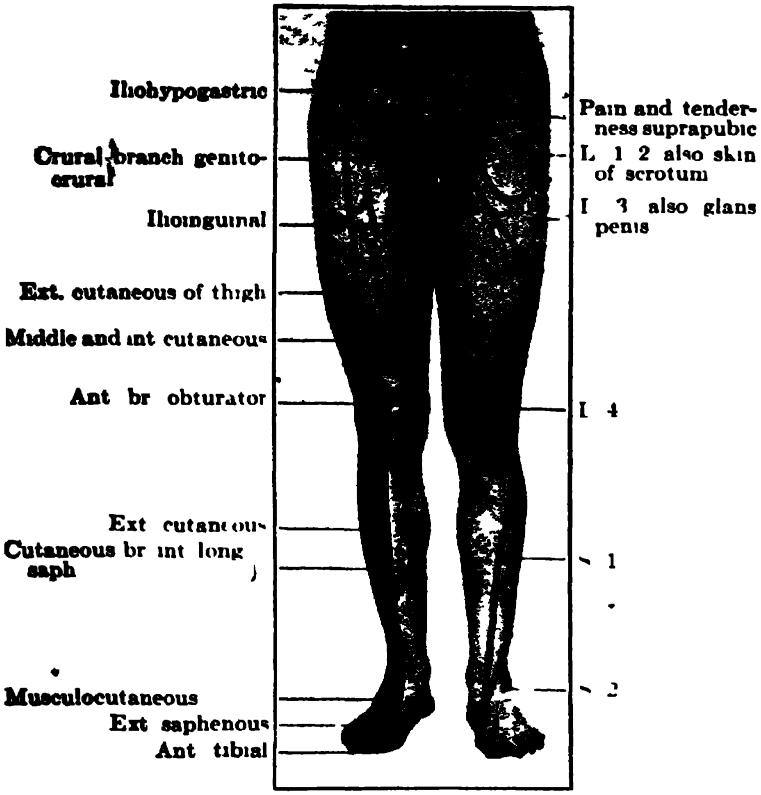


Fig. 161.—Referred Pain in Disease of Bladder
Shaded areas are supplied by the lumbar plexus of nerves and indicate bladder pain Solid black indicates the areas usually involved when the reference is through the great sciatic

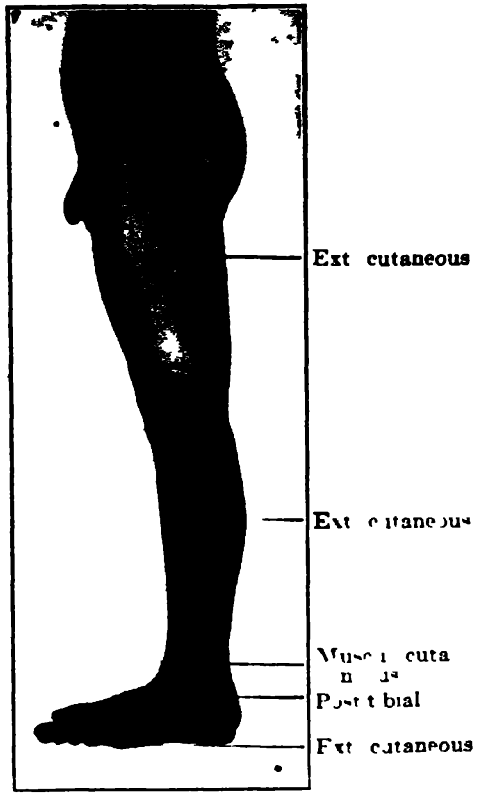


Fig 162—Referred Pain in Disease of Bladder
Solid black indicates the areas usually involved when the reference is through the great sciatic

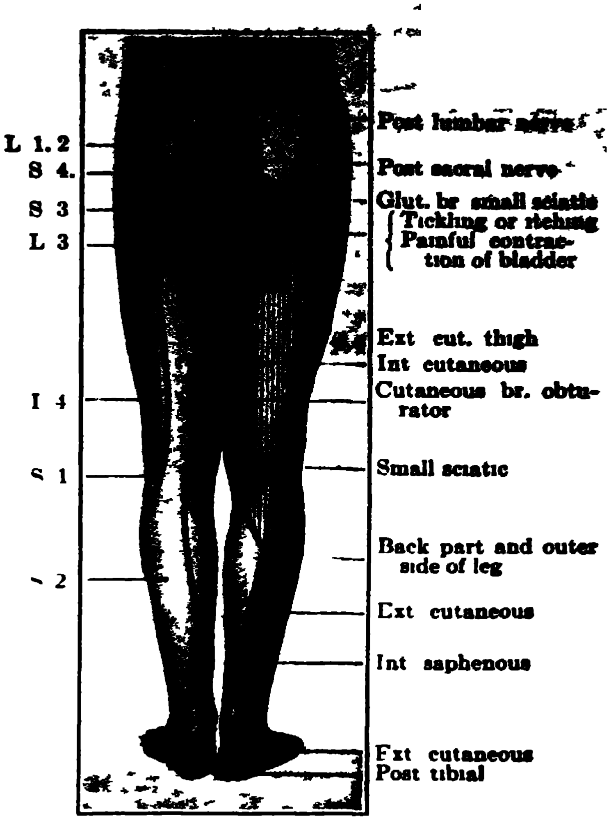


Fig 163—Referred Pain in Disease of Bladder
Shaded areas and solid black as in 161. Cord zonal areas are given on the left, but in them bladder pains are infrequently referred. The crossed lines on the same side indicate the most common areas of reference, according to Kocher.

dragging by these viscera at the time of the greatest activity will produce pain. Should the bladder (in the male) be adherent to the rectum or to the sigmoid, all evacuations of the bowel will be attended with more or less urinary tenesmus and localized bladder pain. Likewise, adhesions to the uterus and tubes in a female will produce the most severe pain during the periods of menstruation, during pregnancy, or during sexual intercourse. In some cases the bowel and urinary bladder have become adherent. In these the pain occurs at irregular intervals, and is frequently accompanied by the *gurgling noise* which betokens bowel contraction. If the adhesions are to the adjacent tissues, pressure in the suprapubic region is painful, especially so if the bladder is full. In woman the bladder can be palpated more easily than in man, and surrounding adhesions and inflammation, because of the *great tenderness* they produce, are easier to define. However, adhesions never cause such severe pain as do intravesicular lesions.

Character of Pain.- Pain due to lesions of the bladder is of two types: constant and paroxysmal. The constant pain is of a dull, aching character, and is felt behind the symphysis pubis. When present it indicates a rather severe inflammation of the bladder walls, for an inflammation that has not progressed beyond the mucous membrane will not produce this marked pain. The constant distress, associated with this lesion, is interrupted by paroxysmal attacks of pain occurring during micturition, slightly before and at the termination of the act, at the time when the two opposing internal surfaces of the bladder are brought into forcible contact with each other by the contracting walls. Should a stone also be present the most severe pain is felt at the end of the urinary act; in fact, the pain may be so severe that urination is inhibited. This pain may be relieved by changing or reversing the position of the patient; for instance, if during the attack of pain the patient lies down, the stone may gravitate away from the urethral opening. The urinary flow is resumed and the bladder pain ceases.

Location.—Nearly all bladder diseases, even those of the least magnitude, cause an aching in the suprapubic region. In some cases this aching is the only discomfort produced by the disease, while in others the aching progresses into acute, severe, and well-marked pain, which may be local, referred, or reflected. If local the pain is due to injury of the terminal filaments of the sensory nerves of the bladder wall, which have become involved in the process. These nerves are spinal in origin, and the pain is perceived as coming from their distribution area. It sometimes happens, though, that the pain is referred to the distribution area of some other of the branches of the nerve involved, as may happen, for instance, in the pudic; where, although the only irritation which may be present is in the branch supplying the lower part of the bladder, the pain may be felt in the glans penis, or in the anal sphincter (see Fig. 159).

A — Congestion of penis

B—Constant pain in glans penis indicates:

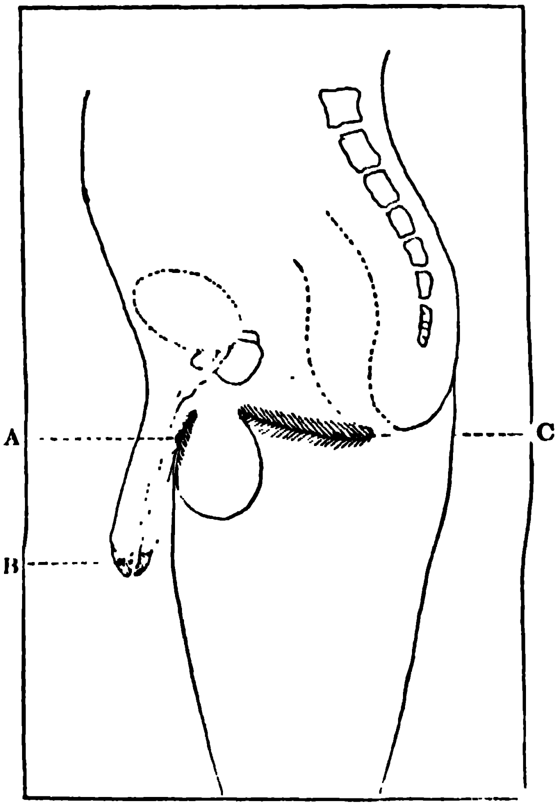
1, Fissure (meatus)
2, Prostatitis
3, Inflammation of the prostatic urethra
4, Ulcer of the urethra

C—Constant pain in:

1, Chronic prostatitis
2, Commencing senile enlargement of the prostate
3, Encysted calculus at the base of the bladder

Pain relieved by micturition in.

1, Acute prostatitis
2, Tuberculous prostatitis (quiescent)
3, Tuberculous bladder



Pain increased by micturition in:

1, Encysted prostatitis at base of bladder behind prostate
2, Ulceration
  (a) *Catarrhal*
  (b) *Tuberculous*
3, Local conditions
  (a) Sub-urethral abscess
  (b) Inflammation of the post urethra
  (c) Impacted stone
  (d) Carcinoma of the bulb

FIG. 164.—REFERRED PAIN IN DISEASE OF THE BLADDER DUE TO INVOLVEMENT OF THE PUDIC NERVE.

When the pain is reflected it is perceived as coming from the distribution areas of the third and fourth sacral segments. These have been shown on page 677. In this connection it is well to remember that the areas in which these pains are most often found are: (1) in the kidney area (probably the result of the backward stasis); (2) over the sacrum, and (3) in the foot, frequently in the heel.

Time of Pain Attacks.— There is no special time at which bladder pain is at its maximum, although from experience with quite a number of cases it seems that night, with its quiet and peace, is the time when the poor unfortunate cystitic feels and suffers the most distress. Often he fears the darkness more than the ungodly fear the evil one, for never does it bring sleep, but always anguish and pain.

Why he should suffer so much more at night is rather hard to say; perhaps it may be that at this time the senses are more acute. During the night they are relaxed from general care, and perceive slighter irritations than otherwise would merit their attention. Another reason is that at night congestion of the retroprostatic plexus of veins occurs. This produces pressure upon the prostatic nerves and possibly also upon the sensitive trigone, and so gives rise to pain. It may also happen that the bladder is fuller at night than during the day, and thus pain is more apt to be produced.

The above description applies to all cases except those in which a stone is present in the bladder. When such is the case the pain is generally worse in the daytime because of the motion which then occurs.

Position of Patient.—The position assumed by the patient during urinary bladder pain when walking is one in which he stoops slightly forward, in a posture similar to that assumed in enteroptosis.

When a stone is in the bladder the patient frequently bends forward, and, if a male, tugs at the foreskin of the penis. This, in some cases, seems to give relief. Why, it is difficult to say. Distention of the bladder also causes the patient to bend forward.

The prone position is not so often sought by the person subject to bladder derangement. As a rule he likes best to sit on a chair, bent forward, with his elbows on his knees. Sometimes he makes pressure over the region of the bladder, though if the inflammation is severe he does so very carefully.

Factors Influencing Production of Pain.—*Relation of Urinary Bladder Pain to Motion.*—One who is troubled with chronic bladder disease is not very active muscularly. Slow, calm, and deliberate in all his movements, he seems the perfect embodiment of caution. He will not run, jump, ride in springless wagons, nor in jolting cars; even walking may become distasteful to him. His life is one living torment, for every motion hurts and injures him. Even rest in bed may be denied him, for it may prove to be only a snare with which to increase his pain. Yet he goes on hoping, always hoping for a surcease from pain.

Relation of Food and Drink to Bladder Pain.—In food and drink lie hidden dangers, for the first may produce bowel disorders which are distressing, and the second may produce urine which burns and scorches. Both bring added discomfort to an already overburdened soul.

Drugs sometimes cause an attack of bladder pain. Witness the frequency with which urotropin initiates one.

Cold air and drafts produce a congestion that may stir up latent disease and cause old symptoms of pain and discomfort to appear again; or, in the presence of an active involvement, they may still further augment the distress.

Tenderness in Disease of the Bladder.—Diseases of the bladder, when they cause pain, are always accompanied by inflammation, and inflammation as a rule produces tenderness. This tenderness of bladder lesions is marked in the three locations in which it is possible to make direct pressure upon the bladder by the examining finger.

The first and most prominent location is immediately above the pubes in the suprapubic region. Here the fingers can be pressed into the abdomen and then, by flexing, can be depressed deep into the pelvis. Should the patient be a child this latter procedure is not necessary, as in children the bladder rides above the pelvic brim. The second location is the base of the bladder. In woman the base of the bladder may be palpated bimanually between a finger placed in the vagina and the palmar surface of the other hand laid over the abdomen. If the bladder is inflamed the patient will complain of pain on pressure between the two. A stone in the bladder or lower ureter can often be palpated by this method. A rectal examination frequently is made in the male, but, as a rule, is not successful in eliciting symptoms of any value because of the great sensitiveness of the prostate.

The third location in which pain in inflammatory diseases of the bladder is particularly marked is the trigone. The pain here is elicited by the passing of a catheter, which when it enters the bladder produces the most intense distress.

Associated Symptoms.—The symptom commonly associated with disease of the urinary bladder is painful and frequent urination. Frequency of urination is one of the first signs of bladder disorder.

Painful urination may also be associated with a new growth. In the urethra the growth may be a caruncle, which is a small raspberry mass lying to one or the other side of the meatus; or a cancer (carcinoma or sarcoma). These are nearly always ulcerated and have acrid discharges, which give rise to severe itching. If the urination is painful and frequent, and pus, but no blood, is present in the urine, it indicates a cystitis, in which the pain is of a scalding nature and occurs during the entire time of the passage of the urine. It is most pronounced at the beginning of the urinary act, and difficulty is often experienced in starting the stream.

Painful and frequent urination, with blood and pus absent from the urine, indicates: (1) vesicourethral fissure, in which the pain is constant and is increased during the urinary act, or (2) pressure upon the bladder by an enlarged uterus, ovarian tumor, or inflammatory mass. If painful and frequent urination occurs, with blood in the urine, the examiner should seek for: (1) tuber-

culosis, in which the blood as a rule is found early in the disease and ceases as the disease advances; tubercle bacilli also may often, if persistently sought, be found in a centrifugalized specimen, while in (2) gonorrheal disease, the gonococcus may often be found on a similar examination; and (3) vesical calculus, in which condition other signs and symptoms of the calculus are present.

Non-painful and frequent urination, with hematuria, generally is the result of tumor, in which the pain becomes noticeable only late in the course of the disease.

Differential Diagnosis.— Bladder diseases should be diagnosed from involvement of the central nervous system. Here the "pain occurs independent of micturition and radiates to the rectum or to the genitals and thigh" (Schmidt).

BLADDER AFFECTIONS CAUSING PAIN

The bladder lesions causing pains are: (1) cystalgia, (2) vesicourethral fissure, (3) distention of the bladder, (4) rupture of the bladder, (5) cystitis, (6) pericystitis, (7) tumors, (8) tuberculosis, and (9) calculus.

Cystalgia.—Montgomery speaks of a cystalgia. Reed is inclined to think that this condition should be described as a hyperemia. He says that while a neuralgia of the bladder may occur, generally it is only a term used for hyperemia. Under the circumstances a frequent desire to urinate is present, with a burning during or after the act. Most of the women so complaining are of a neurotic temperament, and are afflicted with displacement of the uterus, movable kidneys, etc. Fenwick seems to believe that neuralgia of the bladder may exist as a separate entity; and that it is probably produced by the toxins of infectious diseases, as those of influenza or of light septic infections. In some cases pain apparently in the bladder is due to inflammation of the pudic nerve. The pain in this case is also referred to the penis, rectum, and perineum. The perineal pain may be so severe and the perineal surface so sensitive that the sitting posture becomes almost impossible. Traveling on cars also causes the greatest agony.

Pain with incontinence and frequency of urination should lead to the suspicion of tabes, general paresis, etc.

Vesicourethral Fissure.- In this condition the pain as a rule is constant, but is more marked during the urinary act. The constancy of the pain is due to the irritation by the urine of the nerves exposed in the bed of the fissure. It does not seem to make much difference whether the urine is acid or alkaline, the pain (in many cases) being equally severe in both, though the neutral or slightly alkaline urine seems to produce the least pain. Another cause of the constant pain is the steady pressure made upon the exposed nerves by the contraction of the sphincter. The pain of. this condition differs from that of cystitis in that it is sharply circumscribed, while the pain due to cystitis is diffuse. Urination in cystitis gives relief from pain, while in vesicourethral fissure the pain during urination is increased. Tenderness, sharp and localized to the posterior urethra, is also present in vesicourethral fissure, while in cystitis the tenderness is diffused.

Distention of the Bladder. Distention of the urinary bladder is not very painful unless it is of sudden onset, when pain is a prominent symptom. Distention may be due to an acute urethral obstruction from a blocking of the urethra by a calculus or a clot. If the distention of the bladder is the result of lack of sensation or of muscular power in the bladder, it is likely due to a lesion of the brain or of the cord, and may be entirely painless.

In some cases the bladder may be so encompassed by adhesions to adjacent viscera, the result of inflammatory exudates in the pelvis, that only two or three ounces of urine produce a pulling and dragging on the adhesions, and dull aching pain is felt in the areas and regions of the viscera secondarily involved. In these conditions pain is most severe during the urinary act because, by the contraction of the bladder, traction is made upon the surrounding adhesions and pain is produced. This pain is of a more severe type than the dull, aching, continuous pain of distention, and generally occurs as the acme of a pain of gradually increasing intensity. This type of pain is found as a rule only in the female, because a male is free from pelvic disease with its resulting adhesions. The pain is most frequently felt behind the bladder. The intervals between the periods of distention are free from pain. The pain when present may radiate along the urethra to the (testicles) anus and perineum. The two latter, in common with the bladder, are innervated by the sacral plexus. The pain may also be propagated reflexly to the hypochondrium, to both thighs, or be referred to the regions innervated by the anterior crural and sciatic nerves. This radiation is very common in prostate tumors.

Rupture of the Bladder.—Rupture of the bladder is indicated by sudden severe pain in the lower part of the abdomen. It follows a trauma, and is associated with a constant desire to urinate. On attempting to urinate no urine may pass, though the desire does not abate. If any urine is passed it is mixed with blood. In addition, tenderness over the lower abdomen in the prevesicular region is most marked. All cases of rupture of the bladder are not accompanied by pain. A case in point is related by Moullin (226, p. 514) of a man who twenty-four hours after an accident walked into the hospital and complained of his inability to pass urine. Examination disclosed a ruptured bladder.

Cystitis.—Inflammation of the bladder is always accompanied by pain. The cause of this pain production undoubtedly is the irritation of the sensory receptors in the bladder mucosa and of the sensory fibers in the bladder wall structure. This irritation produces more pain when it occurs in the region of the trigone. When it is present there, the entire urinary act may be painful, though the pain is most marked at the end of the act.

Character of the Pain.—In mild forms of cystitis the only annoyance may be a slight discomfort at the time of urination or shortly before it, or if pain is present it is more of a burning or scorching of the urethra after urination than a true pain. This peculiar sensation disappears between the urinary acts, to

DIFFERENTIAL DIAGNOSIS—BLADDER LESIONS

SYMPTOM	RUPTURE OF BLADDER	RUPTURE OF KIDNEY	RUPTURE OF URETHRA
Pain.	More in bladder region. No special radiation.	More in lumbar region. Radiates to thigh.	In perineal region; radiates to scrotum and penis.
Urine.	Contains blood. On catheterization, urine may be absent from the bladder. Frequent and painful urination. Urine or blood may not be passed, though the desire to urinate remains.	No blood may be present. Urine less in amount. Urethral catheterization may disclose no urine coming from the injured kidney. Desire to urinate not so marked. Blood, when it is present, is evenly mixed with the urine. If urine is coming from the injured kidney and no blood is mixed with it, rupture has not occurred.	Urine is bloody, or may be entirely absent, owing to the inability of the patient to urinate.
Tumor.	If the rupture is extraperitoneal, the tumor mass is in the lower abdomen and rides above the symphysis pubis, and fluctuation is present over the symphysis pubis. If the rupture is intraperitoneal, tumor formation may be entirely absent, but fluctuation will be present in the abdomen.	Is present in the lumbar region, and produces a well-marked swelling. This formation fluctuates. If the rupture is intraperitoneal, no tumor formation will be present in the loins, but intraperitoneal fluid will be definable.	Is present in the perineum and scrotum, soft and boggy to the touch. Ecchymosis is marked.
Catheterization.	Catheter easily enters, but passes into peritoneal cavity or adjacent area because of rent in bladder wall.	Easily passes into bladder.	Catheter generally cannot be introduced into the bladder.
History of Injury.	Injury has generally been a crush, in which a fracture of the pelvis has been produced. Any sort of a trauma to the suprapubic region may cause rupture of the bladder.	Injury has been to lumbar region, or in some cases to the abdomen. A crush between bumpers of cars will cause it.	Generally some injury to the perineum has occurred.

recur when the urine is passed. The severity of the pain varies with the intensity of the inflammation. In severe grades of inflammation the pain is most marked. In some cases urinary tenesmus is so great that the unfortunate sufferer is compelled to sit on the urinal for hours before he has relief from the insistent desire to urinate. In the severest forms of cystitis the patient's life is a living torment. Goaded by a constant and unsatisfied desire to urinate, with the most severe pain and local tenderness over the bladder, his existence may be said to be a living hell. In chronic cystitis pain is not as severe as it is in the acute. Should the pain occur only at the end of the urinary act it indicates that the disturbance is in the trigone and the posterior urethra. The lesion most likely to cause this pain is inflammation, which in many cases is of gonorrheal origin. In some cases, spasm of the urethra ensues, and the patient is unable to urinate without the greatest pain. This pain may be so great that he is loath to perform the act, and a partial retention of urine results. However, in cystitis pain is not always present, and may be absent for considerable periods; and even when present may at times be eased to such an extent that the patient is fairly comfortable. Then suddenly, often without any apparent cause, there ensues a very severe, painful and active paroxysm.

Location of the Pain.— The pain of cystitis may be either local or referred. The *local* pain is felt both in the urethra and in the suprapubic region. In the urethra it is most severe during or before the urinary act, though, if the trigone is involved, it may be most severe at the end of the act. In the suprapubic region the pain is felt more as a dull, constant aching, increased at time of urination. Both of these pains are due to the irritation of the terminal filaments of the cerebrospinal nerves supplying the bladder. When the base of the bladder is involved the inflammation may be communicated to the rectum, and severe rectal tenesmus may then result.

The *referred* pain is present in the skin of the scrotum and the penis. These (Piersol) are supplied by the perineal branches of the pudic and inferior gluteal nerves, which are derived from the same segment of the cord as are the nerves supplying the bladder, so that irritation from the bladder may be carried to the cord and thence referred through these nerves to their distribution area. The pain in the lower limbs and foot, especially the foot pain (podalgia), is due to the transmission from the sacral nerves, which form the pelvic plexus, to the lumbosacral cord, which is formed into the great sciatic. Tickling or itching around the anus and painful contraction of the anal sphincter (rectal tenesmus) are present at times, and are most marked when the trigone is affected. Lumbosacral pain is also present. In some cases of cystitis pain has been felt in the region of the umbilicus, with at the same time an entire absence of bladder tenderness (Hilton). The pain may also be referred to the kidney region. In some instances pain due to a lesion at the fundus of the bladder may be referred to the head of the penis.

Tenderness.—In cystitis tenderness, as a rule, is present in the suprapubic area; but Hilton reports a case in which the tenderness to light pressure was a little to the left of the umbilicus, and pain to deep pressure was present toward the loin, no tenderness being felt over the bladder region. The superficial tenderness, it seems likely, was due to some other factor than the cystitis. The tenderness in bladder lesions is most marked at the time of the painful paroxysms. In examining for tenderness, pain is more frequently produced by sudden withdrawing of the hand pressure than by deep palpation.

If the tenderness is marked, and the point of greatest tenderness is in the suprapubic region, cystitis is probably present. This area, in inflammatory states of the bladder, is very sensitive either to palpation or to percussion. In some it is so sensitive that they cannot bear to have the clothing touch it.

Factors influencing attacks of pain in cystitis are:

(1) Anything which causes a congestion of the bladder mucosa or musculature, such as exposure to cold, dampness, menstruation, diarrhea, constipation, or exposure to drafts. These may produce an attack or cause an exacerbation of one already present.

(2) Instrumentation, especially if it is at all rough, brings on an acute and severe attack of pain.

(3) Digestion at times is also responsible for the production of an attack.

The symptoms associated with a cystitis are: (1) frequency of urination, (2) alkalinity of the urine, (3) the presence of pus and bacteria in the urine (the bacteria found are those which have been the chief factors in causing the cystitis), and (4) blood in the urine. This last indicates a cystitis of considerable severity, and is nearly always found in gonorrheal and tuberculous cystitis, and in the later stages of the cystitis due to bladder tumors.

Pericystitis.—Should pain and tenderness be present in the bladder region, and be associated with a mass either in the median line or to one side, and should this follow instrumentation or trauma to the bladder, it is a good sign that pericystic inflammation has occurred. This lesion produces a constant, severe throbbing or aching pain, made worse on urinating. If the process continues an abscess may form.

Tumors of the Bladder.—Pain in tumors of the bladder is of no practical moment, either as an aid in the making of a diagnosis or in deciding how far the process has advanced. It is more prominent in carcinoma than in other tumors of the bladder, probably because, in this form of malignancy, the walls quickly become infiltrated and pressure is made upon the sensory terminal filaments. The infiltration also hinders the contraction of the bladder muscles. When under these circumstances cystitis develops it is very serious, and the pain incident to it is most severe. Tenesmus, out of all proportion to the size of the tumor, is nearly always present in malignant tumors of the bladder wall.

Tumors of the bladder, because they may block the ureters, and thus cause a back pressure and distention of the renal pelvis, also at times give rise to kidney pain. As a rule the malignant tumors are the only ones which are very painful, the pain varying in direct proportion to the nearness of the growth to the trigone. The reason why malignant tumors are so painful is that as a rule they are very friable, and pieces of the tumor mass frequently slough off. These pieces, and in some cases blood clots, are carried to the urethra. If they are not able to pass, a blocking occurs, and bladder distention, which is painful, results. In other cases the carcinomatous tissue invades the wall of the bladder; when it does so, on each contraction of the bladder, pain is produced by the pressure made by the contracting muscles upon the terminal sensory nerve filaments in the bladder wall. The tumor cells may also progress beyond the bladder walls and involve neighboring structures. Then pain due to interference with their functions may be produced, and be referred to the distribution areas of the organs involved. The tumor cells may also infiltrate adjacent sensory nerves. When they do so, severe, continuous, dull, aching pain is referred to the distribution area of the nerves involved.

Tuberculosis of the Bladder.—*Causes of Pain.*—In tuberculosis of the bladder the greatest pain is felt in those cases in which the trigone, the prostate, or the deep urethra are involved. It may cause the most severe suffering. Infections of the upper part of the bladder are not so painful as those of the lower part.

According to Fenwick, the pain of bladder tuberculosis depends upon the depth of the ulceration, the state of the phosphatic deposit, the presence of exposed nerves, and the degree to which the eroded edges are stretched by the accumulating urine.

"Deep ulcerations may not produce any very severe pain, while in other cases congestion or slight ulceration of the mouth of a ureter, or a few miliary tubercles in the mucous membrane of the trigone may increase the frequency of urination and tenesmus, and pain may be excruciating." (Johnston, Surg. Diag., Vol. II, p. 440.)

Character of Pain.—Pain occurs during urination. Generally it follows a period of increased frequency of urination, which as a rule has been present for a long period before the pain commences. Gradually the frequency of urination and the pain increase, so that finally the patient is in a stage of perma-

[illegible] discomfort, with constant urinary pain and tenesmus. The pain is of a burning character.

Time.—The severest pain is felt during the urinary act, and is most severe at the end of the act, when the sphincter closes down upon the posterior urethra. Sometimes the intervals between the urinary acts are free from pain; at other times pain is constant, being aggravated only at the time of urination.

Location.—The pain may be local, referred, or reflected. Local pain may not be present, except at the time of urination. Even then the pain may not be localized to the region where it is produced, but may be referred along the urethra to the glans penis. It is especially severe at the end of the act, at the time the sphincter muscles close down on the sensitive urethra. The other referred pains have been described under the general considerations of bladder pain. The reflected pain is present in the (1) sacral region, (2) the kidney region, (3) the groin, and (4) the thighs.

Factors Influencing Production of Pain.—Position does not influence either the onset, course, or severity of the pain. Motion also does not in the slightest degree modify or change the pain, except in the presence of a cystitis, when the slightest movement may cause the severest pain.

Associated Symptoms.—Associated symptoms of bladder tuberculosis are:

(1) Hematuria, which is present in about ten per cent. of the cases (Johnson). It may precede the onset of pain by an appreciable interval.

(2) Polyuria may be present. It also is frequent in renal tuberculosis.

(3) Pus is commonly found in the urine, and, after a long and careful search of the urine, tubercle bacilli are also, as a rule, discovered.

A confirmative sign of value in the diagnosis of bladder tuberculosis is the presence of tuberculous foci elsewhere in the body.

Foreign Bodies in the Bladder.—Foreign bodies may be present in the bladder without producing pain; however, this is true only in those cases in which the foreign body has no sharp edges, or in those in which, by its position, it does not interfere with the emptying of the bladder. The usual way in which a sharp, pointed foreign body can cause pain is by penetration of the bladder wall and the starting of an inflammation, either of the perivesicular tissues or of the peritoneum. The peritoneal inflammation will produce signs of a peritonitis, while the perivascular inflammation will provoke the symptoms of a pericystitis. (See under the appropriate headings.)

A history of the introduction of a foreign body into the urethra, and its lodgment in the bladder, followed by vesicular pain, is presumptive evidence that the foreign body is the cause of the pain. If the body should lodge in certain parts of the bladder, such as the posterior prostatic space, especially if the space is ample, as it is in those who are old and have large prostates, little pain results. In these patients the bladder walls, on account of the peculiar configuration of the parts, will not be able to contract upon the object, and localized irritative pressure will be absent. One of the commonest foreign bodies present in the bladder is a calculus. Foreign bodies of the greatest variety may occasionally be found in the female bladder. Over a hundred different objects have been found in a single bladder. Such patients use such bodies deliberately for urethral titillation. During use they frequently slip into the bladder by accident or are placed there by design.

Vesical Calculus. *Causes of Pain.* Stone in the urinary bladder generally causes pain, the amount, variety, and constancy of which depend on the position of the stone, its size and shape, and the condition of the bladder wall.

If a stone is located at the opening of the urethra it always produces more pain than it would if it were located in any other part of the bladder. This pain is the result of interference with the proper emptying of the viscus. In these cases, the bladder walls, when they contract, are brought into contact with the stone, which, if sharp and irregular, causes the most severe pain. Often a small stone, if rough and irregular, will produce much greater distress and pain than a larger one with a more regular outline.[1] If the bladder wall is not irritable a stone may be present for long periods of time without causing the least annoyance. This also happens if the calculus, because of its fixation in a diverticulum, be immovable, so that it cannot irritate the bladder wall. Should the stone be rough and freely movable, and in constant contact with the trigone, it causes very severe and constant pain. This pain is very much increased during urination, especially toward the end of the act, but may be entirely absent if, because of incomplete contraction, the bladder does not make pressure upon the stone. If the stone lies in a pouch or depression of the bladder wall, or is lodged behind an enlarged prostate, pain may also be absent. It is also much less in the aged, because of the comparative insensibility of their bladder mucosa. Renal hyperemia and congestion generally accompany vesical stone; these cause parenchymatous enlargement of the kidney, and so produce pains which are referred to the kidney area, so that in some cases, even when the lesion is in the bladder, Head's kidney zones may be present. In such cases, also, the ureteral areas may be free of pain, while the vesicular and the kidney areas may be hyperalgesic; also the typical colic of ureteral stone may be absent.

Character of the Pain.—The pain of vesicular calculus, while it lasts, is very severe. If a cystitis develops, the constant pain may be interrupted by sharp, severe, spasmodic attacks, initiated by urination. The pain is most pronounced at the end of the act, and may persist for some time after. Some patients, while unable to urinate comfortably in any other position, can do so without pain if they lie upon their backs. Sometimes the pain is of such a character that the patients seem to gain ease by pulling up the foreskin after urinating. The pain is always most severe in those in whom the bladder presses down upon and comes into direct contact with the stone.

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[1] Calculi of oxalate, of lime, or of phosphate are the roughest. Those of cystin and uric acid are generally more round and smoother than the former, and cause less pain.

Location of the Pain of Vesical Calculus.—The pain may be either local, referred, or reflected. The local pain is felt in the suprapubic region and in the deep urethra. Referred pain is felt in the glans penis, the perineum, or the anus, the reference taking place through the respective branches of the pudic nerve. The pain likewise may be reflected through the nerve fibers arising from the third and fourth sacral and, in some instances, from the second sacral visceral segments. Through these nerves reflection occurs, so that the pain is felt as coming from the thighs, the hips, the sacral region and, in some cases, from the shoulders and the anus. A sensation is often felt as though a paper of pins were in the rectum (Keen). These referred and reflected pains are always worse when the bladder is full, or when the patient assumes the erect posture. In some cases the pain is radiated into the area of the distribution of the lumbar plexus. It is also said (Head quoting from Erickson) that in some cases there is a dragging sensation in the groins, and frequently a pain in the soles of the feet.

Factors Influencing Pain.— Factors influencing the pain production are:

(1) Motion. Rest is the choice of the patients. They are very cautious about making the slightest movement, for from experience they have learned that motion of all kinds results in pain. Riding in springless wagons, jumping and running are accompanied by pain; for the same reason, rapid walking, jarring, and, in some cases, going up and down stairs are distasteful. After such movements the urine is frequently tinged with blood. Upon rest and quiet the pain ceases and the blood disappears. Violent or sudden turnings or twistings of the body also cause pain. If the stone is small and is freely movable, turning from side to side, or rolling over in bed, generally causes severe pain. This pain is sharp and burning, and is frequently referred to the anus and rectum. Straining at stool will also cause pain. In some cases coughing and deep breathing also produce pain.

(2) Position. The patient generally lies upon his back, since he has found that this is the posture of greatest ease.

(3) **Digestion.** During the active stage of digestion pain is always greater than at other times.

Absence of Pain.—Absence of pain symptoms, when a calculus is in the bladder, is due to:

(1) Anesthesia, of the mucous membrane of the bladder, the result of a cord lesion, such as tabes dorsalis.

(2) Mechanical causes preventing the stone from falling upon the sensitive neck of the bladder, as (a) its adherence to the bladder walls; (b) sacculation of the bladder walls, or (c) pouching of the bas-fond of the bladder, so that pressure cannot be made upon the stone by the contracting bladder walls.

THE URETHRA

Pain in urethral disease follows the course of the twelfth dorsal segment (Head). Urethritis will be considered in connection with the male genitalia. Here will be considered only those conditions connected with the urethra in its essential relation as a urinary organ. These are caruncle and stone.

Urethral Caruncles.—Urethral caruncles, found only in the female, are very painful to the touch. They also give rise to very considerable pain on the passage of the urine. This pain gradually lessens after the act until, in the course of a few minutes, only a slight burning or smarting remains. Intercourse may become impossible because of the very severe pain, or because of the vaginismus which is reflexly produced. In some patients friction from the rubbing of the clothing or from the contact of adjacent parts may become so distressing that moving or walking is hardly possible.

However, in most cases, the pain is not so extremely severe. In some it is most distressing, while in others it is of such a slight degree that it may give rise only to a feeling of discomfort.

The pain is probably due to irritation of the delicate nerve filaments exposed in the denuded surface of the caruncle. It may also be due, in a certain degree, to the greatly increased sensibility of the caruncle, owing to the increased nerve supply.

Calculus.—The passage of a calculus through the urethra causes a burning pain, as though a hot iron were drawn along the passage. If the stone is rough the pain is much more severe. At the same time urination is extremely difficult, and blood is generally present in the urine.

Rupture of the Urethra.—Rupture of the urethra in the membranous portion causes an extravasation of blood and urine into the tissue between the two layers of the triangular ligament. At the lateral aspect of this space are the dorsal nerves of the penis; so that, when extravasation occurs, pressure is made upon them and the pain is referred to the glans penis, although the extravasated fluid collects in the scrotum.

Transferred Pain in Urethral Disease.—Fenwick mentions a case of pain in the foot due to stricture of the urethra. He also records another case of pain in both forearms which occurred during urination. In this patient a prostato-membranous catarrh was found. Both patients were relieved of the pain by treatment appropriate to the urethral condition.

Pain on Urinating. Where pain is felt during urination exact information should be obtained as to the exact time in the urinary act at which it occurs. Pain at the beginning of urination, without a continuance during the act, generally means some obstruction to the onward flow of the urine. This obstruction may be due to a mild urethritis, owing to which the lumen of the urethra is blocked by shreds of mucopus or mucus; or it may be due to a very soft stricture, or to an enlarged prostate that at first offers some obstruction to the onward passage of the urine. A clot or small stone may lodge in the opening of the urethra, and very severe pain and retention of the urine may thus occur. This pain continues until the obstruction has been overcome, when it ceases and urination again becomes free.

If pain be present during the entire time of the urinary act the following should be inquired into:

The presence of irritating constituents in the urine itself, such as phosphates, eliminated drugs (cantharides), urates, glucose, and various ingested acids. The burning may also be due [illegible] too great concentration of a normal urine, so that, owing to that concentration, substances which ordinarily do not irritate do so most severely.

This burning may also be caused by inflammatory states (infiltration, granular patches, etc.) along the urinary tract, either in the prostate or in the urethra. The burning sensation in those conditions is most severe, and at times does not end with urination, but persists some little period beyond. A narrowed meatus also causes pain during urination.

Pain during urination also may be due to inflammatory changes in the bladder walls, or to diseases of or changes in the adjacent organs, such as anteflexion of the uterus, which in a pregnant woman often, owing to traction on the bladder, causes severe pain during the urinary act. Abscess in the prevesicular space of Douglas and pregnancy itself, by its pressure on the bladder, causes pain. Adhesions to different organs by the bladder are also a cause of painful urination, likewise are tumors of the uterine adnexa. The pain in these various lesions is probably due to the hindrance which they offer to the contraction of the bladder musculature, or to the free exit of urine.

Pain at the end of urination is due to prostatitis, urethritis, or to some disease in the bladder. At this time the bladder walls close down, pressure is made upon the trigone, and, if pain is present, it generally indicates an inflammation of the bladder wall or the presence of a calculus, which drops or is pushed into the triangular opening at the beginning of the ureter terminals, and thus, by pressing upon the irritated surfaces, causes pain. This pain is most excruciating. It frequently causes the patient again to attempt to urinate, even though the act has just been performed. Should the pain be present all through the act, and be continued beyond, as a dull, aching sensation in the rectum, it indicates that the prostate.is probably at fault.

Pain continuing beyond the urinary act may, in some cases, be due to urethral changes, as a blocking from a calculus, or a growth at the vesicular orifice, closing the urethra.

CHAPTER XXXI

THE MALE ORGANS OF GENERATION

The male organs of generation are the testicles, epididymis, vas deferens, seminal vesicles, prostate, and penis.

THE TESTICLES

The testicles, when inflamed, become very tender, especially to deep pressure. In testicular affections the skin of the scrotum is not necessarily tender, the testicles and scrotum being supplied by entirely different nerves. The stroma of the testicle receives its nerve supply principally from the sympathetic segments, while the skin of the scrotum is supplied by the genital branch of the genitocrural. Irritative lesions of the testicle cause referred aching or discomfort in the reference areas (deep pressure sensibility) of the eleventh and twelfth dorsal segments. Pain sensibility in the testicle is also conveyed through the genital branch of the genitocrural nerves. The testicle and its coverings being supplied by different nerves, irritation of the different structures will produce pain in different areas, but always in the area with which they have nerve connections. After the testicle has descended into the scrotum, the communication between the testicular sac and the peritoneum becomes abolished, and the testicle lies in a closed sac.

The deep pressure pain produced in testicle disease is due to distention of the capsule. It is a type of sensibility quite similar to that found in other viscera.. Should the distention be gradual pain may be entirely absent. In some cases the testicle grows to a great size, and does not produce any inconvenience other than the dragging due to its overweight.

The testicle is capable, however, of giving rise to severe pain when inflammation causes it to become greatly enlarged. At such a time it is very painful and is extremely tender. Pressure on it causes pain referred to the inguinal region and the inner side of the thigh. In some cases it may be reflected to the back or to the iliolumbar region.

Trauma of the testicle may or may not be very painful. In a case of Mitchell's a wound of the testicle caused pain in the back alone. The deep pressure sensibility of the testicle has a peculiar quality, in that it is often associated with nausea and vomiting.

EPIDIDYMIS, VAS DEFERENS, AND SEMINAL VESICLES

The genital ducts are the epididymis, the vas deferens, with the seminal vesicle as a reservoir.

In a complicated urethritis all of these may become involved, and great inconvenience may result. Yet pain is not a prominent symptom until the inflammation extends far enough to involve the epididymis. Then it is most severe, and is of a throbbing, aching character and, because of the increased blood stasis, is most intense in a standing position. The epididymis, at the same time, is exquisitely tender to the touch, and pressure

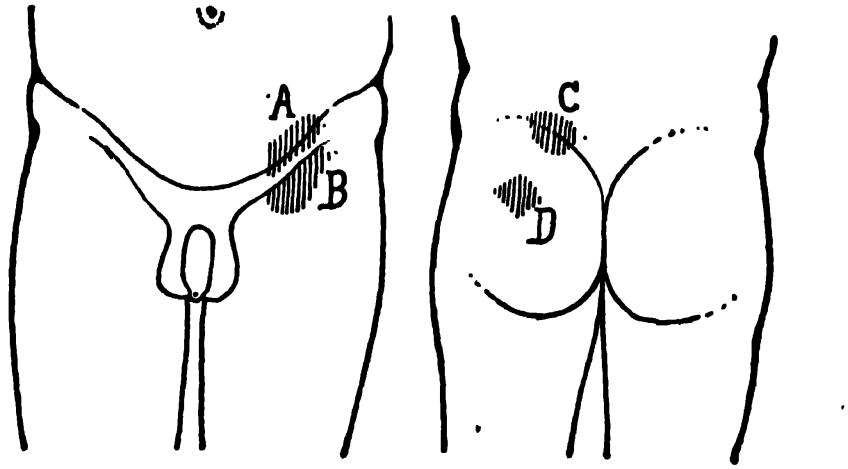

FIG. 165.—AREAS OF CUTANEOUS TENDERNESS IN DISEASE OF THE EPIDIDYMIS.

A and B correspond to the points of maximum tenderness of the 11th dorsal segment. B and C correspond to the points of maximum tenderness of the 12th dorsal segment.

upon it produces the peculiar sickening sensation that is associated with deep pressure on the testicle. Pain when present radiates anteriorly into the distribution area of the crural branch of the genitocrural nerve, and posteriorly over the lower lumbar and the upper sacral vertebræ, which, according to Head, are the areas of the eleventh and twelfth dorsal segments. The pain may also be felt in the leg, as far down as the knee, and in the perineum. Figure 165 illustrates the places where cutaneous tenderness is generally found in inflammation of the epididymis.

THE PROSTATE

The prostate is the principal seat of pain in all acute infections of the male genital tract. Ordinarily the passage of the urinary stream over it is without pain, but when the urethral surface is inflamed, the subepithelial tissue, becoming congested, swells and blocks the urethra. The urinary stream now causes a sudden separation of the urethral surfaces and compression of the tender tissues, with consequent pain production. This pain is most marked in the beginning, and persists during the entire urinary act, and continues for some short time thereafter. If the portion of the gland under the bladder wall is affected, and the inflammation is communicated to the mucous membrane of the trigone, frequency of urination, with severe pain at the end of the urinary act, comes on. Likewise, if that part of the prostate adjacent to the rectum is involved, defecation becomes very painful. Abscess of the gland in any of these regions acts about the same as does an inflammation, but has symptoms of much greater intensity. In prostatic involvement referred pain may also be present in the perineum (through the perineal nerves) and in the back and down the legs (because of the intimate association between the roots of the pudic nerve with the sacral and lumbar plexi) (Bryant, 895).

Congestion and Inflammation.—Congestion of the prostate occurs at times without inflammation, and is found especially in those indulging in sexual excesses. The sensation complained it is more of an aching or dragging across the back in the lumbar region than an actual pain.

However, both congestion and inflammation cause in the glans penis a pain not relieved by micturition. This glans pain is of the referred variety, the stimuli being transmitted through the dorsal nerve of the penis, a branch of the pudic supplying the prostate. The pudic also sends a branch to supply the perineum and the anus, and in both these regions referred pain may be felt.

Lesions.—Lesions of the prostate may also cause reflected pain and hyperalgesia in the tenth and eleventh dorsal, the first, second, and third sacral, and sometimes also in the first lumbar visceral segments. The areas of distribution of these segments are illustrated in the accompanying figure.

In some cases also the prostate may make pressure on the sciatic nerve and thus cause pain which is referred to its distribution area.

The most common diseases of the prostate causing pain are: (1) congestion, (2) inflammation, (3) hypertrophy, (4) new growths.

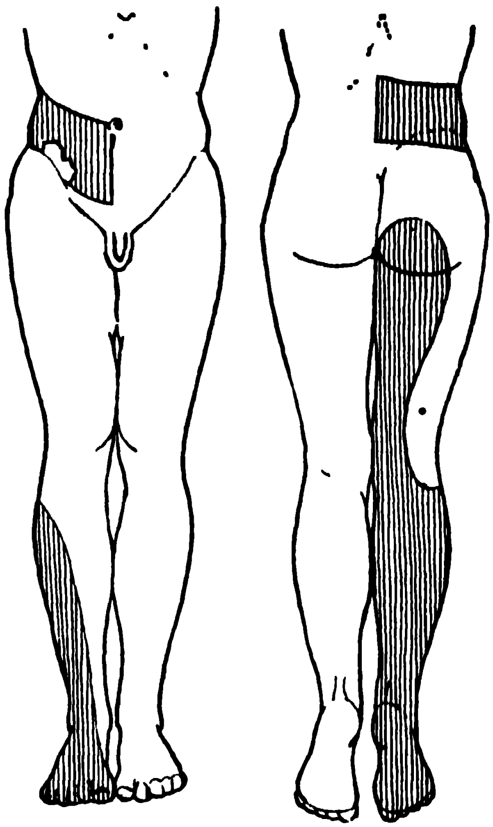

FIG. 166—AREAS OF DISTRIBUTION OF THE 10TH AND 11TH DORSAL SEGMENTS, AND THE 1ST, 2D, AND 3D SACRAL SEGMENTS ON THE RIGHT SIDE

These areas are most frequently involved in prostatic disease. (Head, Brain, Vol XVI, p 85.)

Hypertrophy.—Congestion and inflammation have been considered. Next and closely related to these two is hypertrophy. Generally it is without pain, or, in fact, symptoms of any kind, unless, owing to increase in size, the prostate encroaches upon the neighboring structures and causes some functional disturbance. For instance, no pain is felt in median lobe enlargement until the enlarged lobe causes retention of urine, with infection and consequent cystitis. Then the pain becomes most severe, but it is not the pain of the hypertrophy, but of the cystitis. Hypertrophy of the prostate may cause pain in almost any region, depending upon the changed relationships, pressure, etc., which are produced in the neighboring structures. Some of the places where pain is felt are the glans penis, the back, the hips, the buttock, down the thigh and legs, the foot, and the suprapubic and perineal regions.

Tumors of the Prostate.—The most common is cancer. In it prostatic pain may be complained of only when the bladder is distended with urine. As a general rule, in the soft varieties of cancer, pain is not a prominent symptom. It is usually only when the cancer is hard and the surrounding tissues become infiltrated that pain and discomfort ensue. In some cases, in which the cancer involves the vesicoprostatic portion of the bladder, pain of a spasmodic type occurs. It depends for its production upon the compression of the nerve filaments in the muscular walls of the bladder, particularly so if the lesion occurs in the vicinity of or involves the vesical sphincter.

Tuberculosis.— Tuberculosis of the gland structure is not painful unless neighboring tissues are involved. Calculi, likewise, may be present in the prostate without causing pain.

Associated Symptoms.—Associated symptoms of prostatic involvement are:

(1) Frequency of urination. This is one of the most characteristic symptoms. Commonly, when the prostate is not acutely inflamed, urination is frequent, but is entirely free of pain.

(2) On passing a sound the most extreme agony is experienced by the patient as it passes over the prostatic portion of his urethra.

THE PENIS

Pain felt in the penis may originate from conditions present in its substance, involving principally the urethra, or it may be referred from distant lesions.

Urethritis.—The lesion of the penis causing the most pain is, in the vast majority of cases, an acute inflammation, generally gonorrheal, of the urethra. Inflammation of the urethra causes pain in urination, which, however, is more of a burning sensation, or, as some of the patients put it, "a feeling as though they were passing hot oil," than an actual pain. The irritation is often transmitted to the head of the penis, where it is felt as a severe stabbing. When the urethra and adjacent tissues are inflamed erection causes acute pain. Owing to the structure of the penis inflammation, when the spongy body only is involved, causes it, during erection, to be bent on itself. Many misguided individuals, ignorant of the true nature of the pain production, have attempted forcible straightening of the penis in such conditions, with resulting rupture of the urethra.

Referred pains felt in the penis may originate in lesions of the kidneys or ureters, in prostatic diseases, in some spinal cord conditions, and occasionally from rectal disorder.

Inflammation of the prepuce (balanitis) causes a pain that is especially marked on erection of the penis. In the state of erection the prepuce is stretched, normally, without any special sensation, but should it be inflamed, pain results. Pain is also produced by the rubbing of the clothing against the inflamed and eroded surfaces.

Inflammation of Cowper's Glands.—Sometimes the glands in the bulbo-membranous urethra, known as Cowper's glands, become inflamed. When they do, pain is felt in the perineum, where, on palpation, a painful mass may be palpated. The pain is greatly increased by motion, such as walking; defecation and the sitting posture also increase the pain, which is of a throbbing character. To cause this throbbing it is not necessary that the congestion be severe, for the glands lie between the two layers of the triangular ligament and are inclosed in perineal fascia, so that the least engorgement is resisted, and gives rise to pain.

The glans penis itself, generally, is not painful. Examples of an ulcer of the glans being present without the patient's knowledge are common. Indeed, he may not be aware of anything abnormal until the skin is involved, or until lymphangitis or lymphadenitis occurs. However, the penis is not absolutely without sensation, for it is capable, probably more so than ordinary organs, of appreciating different degrees of pressure. (Head and Rivers, 86, p. 39.)

CHAPTER XXXII

PAIN IN THE FEMALE GENITALIA

GENERAL CONSIDERATIONS

Anatomy.—The female genitalia consist internally of the uterus, Fallopian tubes, and the ovaries, and externally of the vagina. The internal organs lie deep in the pelvis, and are protected against traumatism by the bony wall which surrounds them. This wall, although it serves the purpose of a protection to the sexual organs at the times when the organs, enlarging for some reason, cannot accommodate themselves without making pressure on the surrounding structures, also is a cause of pain and distress. The free mobility of the uterus and adnexa helps to overcome, in a measure, the structural disadvantages of its location.

The peritoneum, which covers the uterus, tubes, and ovaries, is reflected over the anterior and posterior surfaces of these organs, and on either side forms the two layers of the broad ligament. The uterus lies in front of the rectum and posterior to the urinary bladder. Any enlargement or distention of the rectum causes a displacement of the uterus, raising it up and throwing it forward. Normally this causes no discomfort, but when inflammation, with its accompanying adhesive formations, arises, this free mobility is curtailed, and change of position causes pain. Owing to the close anatomical connection and relationship of the uterus with adjacent organs, any inflammation or derangement of the economy of these organs has an unfavorable influence upon the uterus, either through the nervous system or the circulatory supply, and may lead to pain production.

Nerve Supply.—The female genitalia receive their nerve supply from both the sympathetic and the cerebrospinal systems, the sympathetic being distributed to the upper part of the uterus, the tubes and the ovaries, and the upper part of the vagina, while the cerebrospinal nerves are distributed to the lower uterine segment and the vagina. The ovaries and tubes are supplied entirely by the sympathetic, the nerves supplying the ovary and the *distal* extremity of the tubes being derived from the ovarian plexus, which, in turn, receives its fibers from the fourth and fifth lumbar ganglia of the sympathetic. The proximal end of the tube and the upper part of the uterus receive their supply from the uterine plexus, and this also derives most of its fibers from the fourth and fifth lumbar ganglia of the sympathetic.

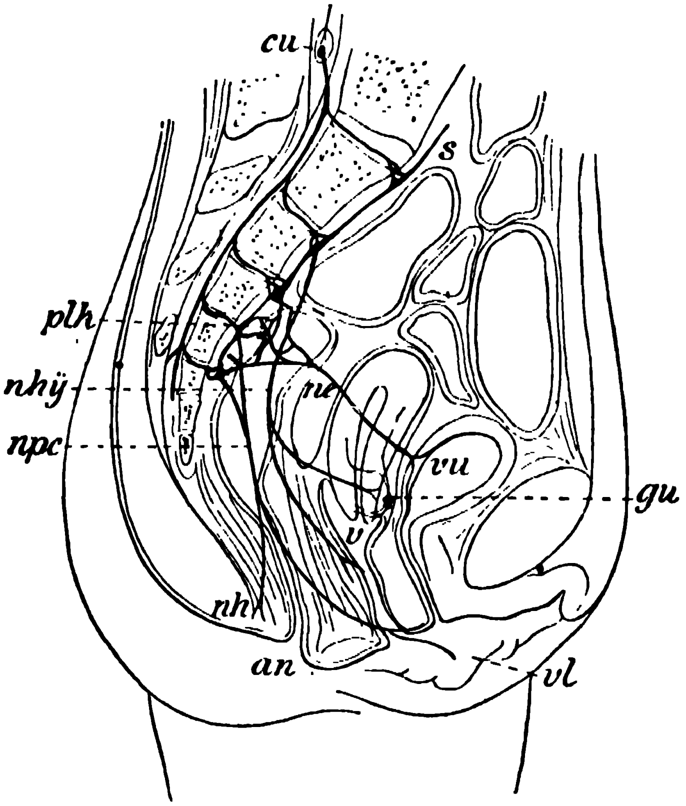

FIG. 167.—NERVE SUPPLY OF FEMALE GENITALIA. cu, spinal uterine center; plh, hypogastric plexus; nhy, hypogastric nerve; npc, nerves pudendres communis; nh, hemorrhoidal nerves; gu, peripheral ganglion in vaginal form; s, vagina; vu, bladder; vl, vulva; an, anus. (Bechterew's "Functionen der Nervencentren.")

At this point it is well to recall that the lumbar ganglia do not correspond with the lumbar visceral segments of the cord, as described by Head. The nerves which pass through the ganglia may arise from much higher segments of the cord than the ganglia through which they pass would seem to indicate. The segmental supply will be considered on p. 713.

To understand better the nerve supply of the female genitalia each organ will be considered separately. The supply to the ovaries and tubes will first be traced, and then the supply to the uterus and vagina.

The *ovaries* are probably supplied entirely by sympathetic fibers (Luschka, Van Hoerff), which are derived from a plexus surrounding the ovarian artery. This plexus, in turn, is formed by nerves from the renal and aortic plexi, and thus is in intimate connection with the abdominal sympathetic; so that any derangement of the ovaries may produce sympathetic disturbance in the abdominal viscera. The plexus surrounding the ovarian artery sends fibers into the ovary, to form plexi surrounding the larger blood vessels. A plexus is also formed in the cortex and sends nerves to the periphery, to end on the surface between the germinal epithelial cells, or in the follicles, where they terminate in the walls of the blood vessels. None of the fibers penetrate beyond the theca. In opposition to the view that the ovaries are supplied entirely by sympathetic fibers is that of Head and Rivers (86), who hold that the ovary receives a part of its nerve supply from the abdominal wall, its innervation probably being connected with the last dorsal and first lumbar nerves. However, this is likely true only of the peritoneal covering which the ovary has acquired during its developmental descent, for in early fetal life it lies close to the abdominal wall, beneath the peritoneum.

The *Fallopian tubes* receive their nerve supply from the sympathetic. The nerves follow the arteries and reach the tubes from the ovarian and uterine plexi (cervical and corporal). After reaching the tubes the nerve fibers penetrate into the peritoneum and immediately beneath it form a plexus (the subserous), from which some nerves are given off to supply the muscular tissues, and others to form a subepithelial plexus, which lies in and supplies the mucous membrane.

The *uterus* is supplied both by the sympathetic and the cerebrospinal systems. The sympathetic is distributed chiefly to the body of the uterus and is formed into two plexi, the smaller of which lies upon the upper and lateral surface somewhat posteriorly, and is distributed to the posterior and lateral surfaces of the uterus. The larger is distributed to the cervix and the vaginal vault. One of these ganglia is especially large, and is called the cervical ganglion. It lies behind and to the side of the cervix. The uterus, in addition to the sympathetic fibers, receives medullated fibers from the second, third, and fourth sacral nerves[1] (third and fourth sacral, Novak), which also supply the vagina, and, through the pudic, are distributed to the perineum and the bladder. Therefore, when the lower uterine segment is affected, pain may be felt in the bladder and the perineum.[2]

In the uterus the course of the sympathetic and spinal nerve fibers is different, the sympathetic fibers being distributed to the blood vessels, while the spinal fibers terminate between the muscle bundles and in the mucosa (Piersol), but are probably not found above the cervix. It is because of the intimate relationship of the cerebrospinal fibers to the uterine musculature that uterine spasm is so specifically localized to the uterus,[3] because, when the uterus contracts, the nerve filaments are caught between the individual muscle bundles and are tightly squeezed. This irritation produces the sensation peculiar to the uterine contraction, and is called uterine "colic."

The nerves of the uterus show great ability to adapt themselves to changes in size of the uterus. This is well seen during pregnancy, when the uterus enlarges to many times its normal size. The nerves increase in size but not in number. The ganglia also increase in size; naturally they will be somewhat stretched, and this stretching produces irritation, which is transmitted to the cord, and is reflexly felt as a pain or aching in the back or down the thighs in the area of distribution of the cord zones connected with the uterus.

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[1] Bechterew, quoting from Rein and Pisemsky

[2] According to v Bisch and Hofman (379), there are two sets of nerves in the uterus the nervi uterini, reaching the uterus by way of the hypogastric and sympathetic nerves, and the nervi uterini sacralis, passing from the main sympathetic chain, and belonging to the pelvic splanchnics (Korner, Robling, 378) The stimulation of the hypogastric nerve causes a contraction of the circular muscles of the uterus Stimulation of the cerebrospinal nerves causes the longitudinal to contract

[3] Since the stimuli carried to the brain over cerebrospinal tracts are definitely localized to the area in which they are produced, any stimuli occurring in the spinal nerves supplying the uterus would be referred to the area in which they are produced, viz, in the lower uterine segment. The localization of the pain is not as definite as it would be if some of the somatic nerves were involved, for one of the chief functions of the somatic nerves is to interpret pain, while those of the uterus are concerned more with nutrition and muscular tone So that pain stimuli present in the nerves supplying the uterus are not interpreted definitely as coming from the uterus, but are referred to the area of distribution of the pudic, one of the functions of which is to transmit pain sensation.

The sensibility of the uterus, ovaries, and tubes to ordinary stimuli is very slight, if it is present at all, so that, on exposure, during operation (cocain anesthesia), a normal ovary can be pinched with a clamp or a mouse-tooth forceps without the patient's knowledge. The same can be done, in the majority of cases, with normal tubes (Sampson, Meyers, 152, p. 749). Deep pressure upon an ovary produces that peculiar sickening sensation so familiar in the male when the testicles are squeezed. Some women are more sensitive to ovarian pressure than are others. Intrapelvic manipulation is usually less painful in women past the menopause, and also less painful in those who have borne children. Most observers agree that the uterine, tubal, or ovarian peritoneum is not very sensitive to traction, to pressure, or to gauze rubbing against it, but that the parietal abdominal peritoneum is most sensitive to these same stimuli.

The cervix uteri is insensitive to touch, but is very sensitive to crushing or dilatation. The endometrium is as a rule without pain sensation (Novak), though when inflamed it may give rise to a sensation of weight and heaviness. In this condition intrauterine points or areas of tenderness may develop (see under Uterus).

Diagnosis of Pelvic and Hysterical Pain.—*Pelvic Pain.*—If the patient complains of pain, and pelvic disease is suspected as a cause, inquiry should be made as to the periodicity of the pain, its exact location, its relationship to the menstrual period, and the history of past diseases. If such inquiry is made, it will be found that pain, if it is due to pelvic lesions, will have some or all of the following characteristics:

(1) It is either constant, with periodic exacerbations corresponding to the menstrual period, or is present only at the time

of menstruation; (2) it is felt in the lower abdomen and radiates to the back or lower limbs, or it is felt in the right or left iliac region; (3) it is associated, in quite a fair proportion of cases, with a tender point one to one and one-half inches below, and three-quarters of an inch internal to, the umbilicus (Morris's point).

In regard to the anamnese, careful questioning of these patients will generally elicit the fact that at some time in the past they have suffered from parametritic inflammation. Yet great care must be exercised in judging of the value of subjective symptoms, as given by the patient, for, at the present time, because of the prevalence of pelvic diseases, and the diffusion of knowledge concerning their symptoms, it frequently happens that a hysterical patient will simulate a uterine or ovarian disorder so closely that it is very difficult to make a diagnosis.

However, in nearly all cases a fairly positive diagnosis can be made, for, as Eulenberg says (145, pp. 1274-1275): "Spontaneous recurring pains in the inner or outer genitalia (in the pelvis, coccyx, or abdominal wall), when they are the exclusive or predominating symptom, if they occur without positive organic findings, independently of the quality, intensity, persistency, and former quality of the pain, speak first against the acceptance of a genuine local disease, and eventually for a clear nervous cause, in the sense of neurasthenia or typical pain of psychical hysteria.

"In any case spots, painful upon pressure, can only be regarded as affections of genuine genital suffering if they can be referred back to a local change; for instance, to enlargements of the ovaries, or to parametritis. Should the pain, present on pressure, remain in the same place, on the same side, and exist at certain periods (menstruation) organic lesions are indicated, while vacillation, irregularity, changes of the kind of pain occurring periodically, and resistance, point on the contrary to the neuropathic causes."

Hysterical Pain.—When pain is present in the ovarian region, hysteria should be considered as a cause; the hysterical origin of the pain may be proven by finding pressure points on other parts of the body (Windscheid, 148, p. 484). Another point which aids in diagnosing hysterical pains is that they bear no relation to sensory nerve distribution, nor to segmental cord distribution (Dercum, 150, p. 849).

Another point aiding in the diagnosis is that pain due to hysteria does not, as a rule, subside upon rest in bed, while pain due to inflammatory disease of the pelvic organs usually does. This is not invariably so, because many cases of hysteria and neurasthenia are greatly benefited by rest in bed, owing to the improvement in the general health which then ensues (Rothrock). In hysteria, also, there is, as a rule, diminution or absence of the conjunctival and pharyngeal reflexes (Windscheid). Hysterical (or neurasthenic) pain is confined to the left side. In hys-

DIAGNOSIS OF PELVIC FROM HYSTERICAL PAIN

Symptoms	Pelvic Disease	Hysterical Pain
Pain.	Has definite location and remains constant in this location. It makes no difference whether the patient's attention is attracted elsewhere or not, pressure over the site of the pain will produce an exacerbation of it. Menstruation usually influences the pain, generally increasing it.	Has no definite location, but flits from one place to another. Pain often is of a burning character. Frequently, when the patient's attention is attracted elsewhere, severe pressure can be made over the indicated site of the pain without initiating it if it is not present or without increasing it if it is present. Menstruation usually has no influence on the pain.
Fever	May be present in acute disease	None
Leukocytes	May be increased in acute attacks	No increase
History	Generally of gonorrheal, tubercular, or puerperal infections, pelvic tumors, or of pelvic traumatism	No history of gonorrhea, etc., but one of neurosis.
Reflexes	Conjunctival and pharyngeal present	Conjunctival and pharyngeal absent
Areas of hyperesthesia.	Absent.	Present

teria (neurasthenia also) there seems to be a lessened resistance to pain production in lesions of the female genitalia. This causes them to react much more strongly than normal to the slightest irritation (Dercum, 347; Herman, 316); so that when the pelvic disease has produced a secondary neurasthenia or hysteric weakness the pain may, after removal of the cause which has originally produced it, persist and be renewed on the slightest stimulus arising from causes which, in a normal state, would not produce even a discomfort.[1]

As an aid in the diagnosis of these conditions a diagnostic chart is given on page 711.

Varieties of Pain. In some patients a long-continued lesion has produced so much disturbance in the nervous system that a permanent state of nerve weakness has occurred, and the patient suffers from the condition termed neurasthenia. She is now particularly unfortunate, for her years of suffering have so reduced the resistance of the nervous system, and the pathways for pain have been so well defined, that irritations, even those of the least magnitude, are interpreted as painful. It should not be forgotten, however, that the term "female complaint" is often used as a subterfuge for weak, irresolute, or lazy souls to indulge their innate propensities for idleness.

So far we have been speaking of pain and painful areas, not specifying definitely their location, and therefore before we advance further it will be well to consider more exactly the limits of these areas in which pelvic pain is felt.

In doing so, it is again necessary to draw attention to the fact already stated that the pelvic viscera, unlike most of the other abdominal viscera, have two sources of nerve supply: the sympathetic and the cerebrospinal. The cerebrospinal system, as is known, refers all its irritations to the peripheral distribution of the particular nerves concerned, while the sympathetic carries the stimulus to its centers in the cord. Here the irritation is communicated to adjacent centers of the cerebrospinal system, by which it is relayed to the brain, where it is perceived as coming from the peripheral distribution area of the nerves connected with these centers. Thus the pains due to cerebrospinal irritation are more apt to have an exact orientation than those due to irritation of the sympathetic system. This is exemplified in uterine muscle-contraction pain, where the localization is somewhat exact and the pain is of considerable magnitude, because it is due to cerebrospinal involvement; while in endometritis, the pain, when present, is indefinitely placed in the lower abdomen, is referred to the back, to the hips, or to the lower limbs, and is of less intensity, being more of an aching than a pain, because it is of sympathetic origin.

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[1] According to Fritsch (348), pelvic pain persists in 33 per cent. of the cases after corrective operations.

The sympathetic supply of the body of the uterus seems to be from the tenth, eleventh, and twelfth dorsal segment [first or first and second lumbar (Donald and Lickley)], while the lower uterine segment is supplied by the third and fourth lumbar, and sometimes the first and second sacral segments [second, third, and fourth sacral (Donald and Lickley)]. In this connection it is always well to remember that the sacral segments do not by any means correspond to the sacral nerves. The sacral segments are concerned principally with the dilatation of the cervix, such as occurs in the first stages of labor, while the dorsal segments are concerned principally with the contraction of the uterus. In Fig. 168 the distribution areas of the different segments are defined.

By an examination of this figure it is seen that the uterine corporeal pains are referred to the lower abdomen and back, while the cervical pains are referred to the sacral region, the back of the hip and thigh, and the lower and back part of the foot. The pains due to the ovary are reflected to the tenth dorsal visceral areas, and those from the Fallopian tubes into the eleventh and twelfth dorsal and first lumbar visceral areas.

In this respect a peculiar characteristic of the genital pain to be noted is that, irrespective of the location of the lesion, the pain is most common on the left side.

Novak (117, p. 480) states that Champneys, in a series of cases of uterine cancer, found the proportion between left-sided pain and right-sided pain to be as six is to one, and in these cases no greater tendency to involvement was present on the left than on the right. Herman, likewise, found that, in cases of retrodisplacements of the uterus, pain was three times as frequent on the left as on the right side, without regard to the frequency of the displacement on the same side. Herman ascribes

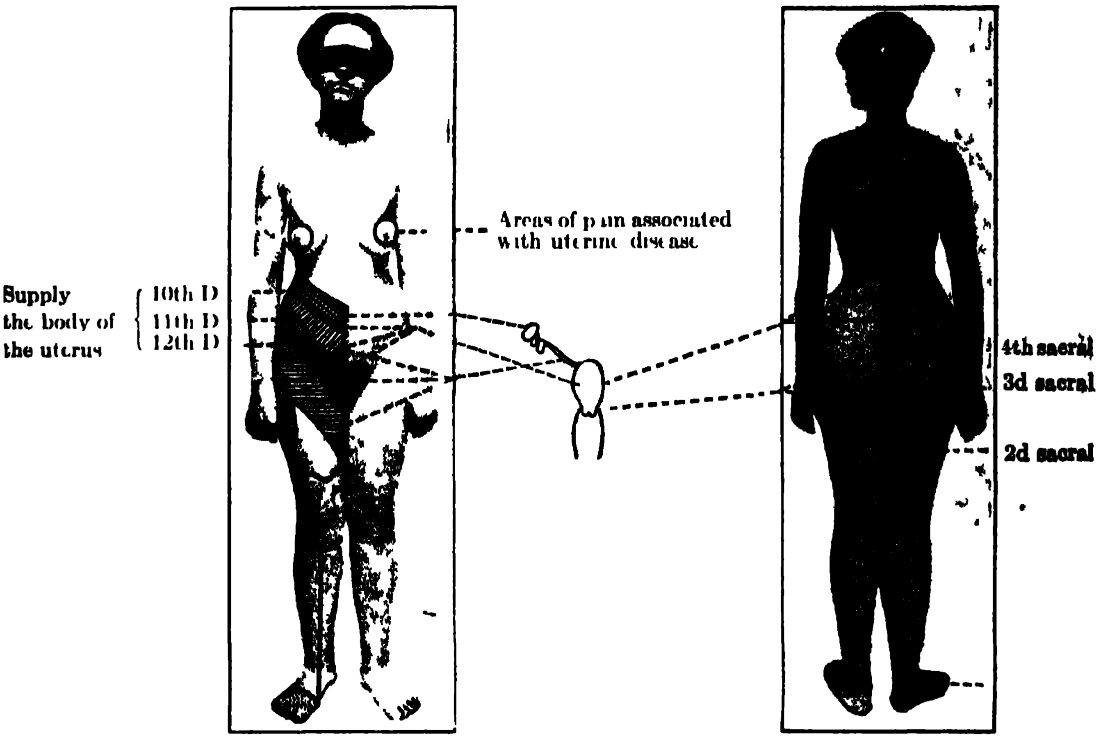
Areas of pain associated with uterine disease
Supply the body of the uterus
10th D
11th D
12th D
4th sacral
3d sacral
2d sacral

FIG 168 AREA OF DISTRIBUTION OF CORD SEGMENTS INVOLVED IN UTERINE, OVARIAN, AND TUBAL DISEASES

The body of the uterus is supplied by the 10th, 11th and 12th dorsal segments, the cervix by the 3d and 4th lumbar and sometimes by the 1st and 2d sacral segments, the ovary by the 10th, and the Fallopian tube by the 11th and 12th dorsal and the 1st lumbar segments.

the greater frequency of pain on the left side to the fact that the left side is weaker and less resistant than the right. According to Herman (144, p. 1,056), the greater frequency of pain on the left side has been fancifully explained as being due to a shortening of either the left tube or of the left ovarian ligament. It is also explained by Clark (350) as being due to tension of the tightly drawn mesentery over the brim of the pelvis. It may also in many cases be partially explained from the fact that on the left side (in hysterically inclined subjects) there is usually a hysterical zone in the region of the ovary (Charcot).

Sympathetic pains, occurring in the occiput and breast, are very frequent in disease of the female genitalia. The presence of the breast pains cannot entirely be explained on the hypothesis that the stimuli are carried through the nervous system, although it is probable that the nerve supply of the breast has a more special connection with the genitalia than with other organs. The pain in the head, and particularly that in the breast, seem to be due to an active congestion of the meninges and of the breast respectively, so that, in pelvic disease, at the time when the pain appears in the breast, the mammary gland swells, becomes tender, and the pain is (frequently) of the dull, aching variety that indicates capsule tension. When the pain is felt in the head the meninges are probably likewise congested, and the headache is likely due to increased intraventricular tension.

The cause of both these congestions may be a toxin or ferment either of uterine or of ovarian origin circulating in the blood. This substance has a selective action on the meninges and on the breast; the breast, because of the related sexual functions of the two; and the meninges, because they seem to be particularly sensitive and reactive to deleterious circulating substances of any kind.

As yet a substance of this nature has not been separated from the blood, nor has one been produced from the uterine or ovarian tissue, though the actuality of its existence seems to be strengthened by the fact that during gestation, with all nerves divided, the mammary gland develops. The only way a stimulus could be carried to it is by the blood (Mott).

A peculiarity of breast pains, that might seem to show that the uterus and the breasts are correlated through the nervous system, is that breast pain is most frequent on the side in which the diseased organ is located. If the causative factors were carried through the circulation, why should the breast on the diseased side be more frequently involved? As yet no clear explanation has been offered.

As a conclusion it may be stated that the female genitalia are capable of producing local, referred, reflected, transferred and sympathetic pains. The transferred pains are found in some cases of salpingitis, in which the pain is felt on the side opposite to the one in which the lesion is located. Nearly all surgeons have had experience of such cases.

Character of Uterine Pains.—While a description of uterine pains may entail some slight repetition, yet, for the sake of clearness, we shall again very briefly consider them. As has been said, they may be classified as constant and intermittent. The constant pains are those due to a continuously acting cause, such as is found in inflammations (endometritis, metritis, salpingitis, and oophoritis). Exacerbations frequently occur, producing intermittent pain, and usually indicate uterine contractions. Constant pains, varying in intensity on change of position, are found where inflammation has been followed by the formation of adhesions. These adhesive formations are a potent cause of pain production during the functional acts of the parts involved. For instance, where the uterus is attached by adhesions to the bladder wall, urination, owing to a lessened capacity of the bladder, the result of traction, etc., by the adhesions, becomes frequent and generally is painful; likewise adhesions to the rectum are the cause of pain during defecation, and in some cases pain is felt as soon as the fecal matter begins to accumulate in and distend the sigmoid.

Position Assumed by the Patient Suffering from Pelvic Visceral Pain.—Some women who are afflicted with uterine or adnexal disease have no rest in any position; standing or walking, in motion or at rest, they are always subject to distress. Their pains, like an unwelcome heritage, are ever with them. On the other hand, there are others who have pain only when they assume certain positions or perform certain acts. Very familiar is the woman who is always complaining of her back. She has a constant, steady aching, that is made worse on bending and on flexion of the body. She will prove to be one who has a displaced or retroflexed uterus. Women who not only have pain on standing but on lying on one side will frequently be found to have an acute inflammatory state of the adnexa on that side. Some women, though, seem to have ease by lying on the affected side. Bending forward or backward is particularly *painful* in all pelvic disease. Especially in *inflammatory* states of the pelvic peritoneum are frequent repetitions of the same act very painful.

On ascending stairs pain in the inguinal and lower abdominal region, coming on as the foot is being removed from the ground, generally indicates an involvement of the psoas muscle or its sheath in the inflammatory adnexal disease. Pain on elevating the arm indicates an increase of intraabdominal pressure and disturbed peritoneal relations. This is common in adhesive formations and in pelvic peritonitis.

If the adhesions are to the small bowels intestinal peristalsis is painful. Pain of this sort comes on at irregular intervals and is of varying intensity. It is frequently accompanied by a gurgling which indicates the reduction of a stenosis and the onward passage of the bowel contents, with an almost immediate relief from the pain.

Relation of Pelvic Visceral Pain to Functional Acts.—In all acute and some chronic inflammations of the pelvic viscera, and in those cases of adhesive union between different viscera, pain is present on *coitus.* This pain may be severe during the entire act or may be present only at the end, and, in either case, may persist for some time after the act. When it is present during the entire act it is generally due to an acute inflammation, which has progressed beyond the uterus and has involved the adnexa. This pain persists, as a rule, for some time after the act. In chronic pelvic inflammation the pain may often persist throughout the next day. The site of the inflammation modifies the pain to a great extent. Inflammation high in the body of the uterus generally does not cause as much pain as if the inflammation were low down in the cervix. Of course, vaginitis or cystitis will also cause pain, and should be considered. This pain is present on the entrance of the male part, while the pain of the inflammatory and adhesive states is present only during the act, and, in many cases of mild inflammatory states persists only during the time of the active movements. When it persists after the cessation of these movements it is a sign that some damage has been done to the female parts. If the patient has pus tubes, a pain persisting in the tubal area after the completion of the sexual act may, in some cases, indicate a leakage from the tube, with a peritoneal irritation. Pain on entrance of the male organ into the vagina may indicate a bartholinitis, fissures, sometimes growths, or a tight introitus, either of spasmodic (vaginismus) or organic origin.

A pain, or rather an aching and discomfort, only present at the time of and at the completion of the sexual act (orgasm) indicates an endometritis.

Menstruation acts as an exciting cause to pain production in many cases of pelvic disease. When the pain comes on prior to menstruation it indicates an existing inflammation, very frequently of the tubes. Frequently, also, it is the best sign of a cirrhotic ovary. Pain during the early stages of the menstruation indicates (generally) a stenosis of the cervix, while if present during the entire time it indicates an inflammation of the uterus or adnexa. Pain existing prior to and relieved by menstruation indicates a uterine congestion, a very probable cause of which is fibroid tumor.

Relation of Pelvic Visceral Pain to Motion and Change of Position of the Patient.—In diseases of the genitalia all vibratory motion produces pain, which is especially well marked during violent movements, such as occur during horseback riding, jumping and running. A form of motion particularly productive of pain is that which occurs in sweeping, and in the lifting or moving of heavy objects.

This pain probably depends for its production upon the increase of the intraabdominal pressure, due to contraction of the muscles of the abdominal walls. Certain functional acts, such as vomiting, also incite pain. The vomiting causes extremely marked variation in the intraabdominal pressure and visceral relationships, and this probably leads to the pain production.

Certain ordinary acts of every-day life may also be productive of pain, for instance, a patient who has a unilateral pelvic inflammation finds it difficult to sit down and cross the limb of the affected side over the other limb in a posture which I have called "lacing-the-shoe position" (q. v.). Pain during this act is due both to the direct pressure of the limb against the tender abdomen, and to the *stretching* of the psoas and the *increase* of the intraabdominal pressure.

In all cases where inflammation is beginning to spread from the pelvic viscera to the adjacent tissue the patient voluntarily seeks quiet, and, because of the resultant pain, is not easily aroused from her lethargy.

Tenderness due to pelvic lesions can be elicited either by abdominal or vaginal examination. The abdominal examination is divided into the superficial and the deep.

The superficial examination is limited to defining the areas of hyperalgesia. The limits of these areas have been given under the heading, Reflected Pain (q. v.). The value of these diagnostic phenomena in pelvic disease is that they frequently offer a "leader" as to where to search for the lesion causing ill-defined abdominal pain and discomfort. As no physician or surgeon relies absolutely upon one symptom in forming a diagnosis, so the phenomenon of hyperalgesia should not be taken as pathognomonic of any one disease, but rather should be used as an aid in confirming or contradicting the conclusions arrived at by other means.

Tenderness produced on deep palpation is more reliable and helpful than that produced by superficial palpation. Where tenderness is being sought for, the relationship of the pelvic viscera to the anterior abdominal wall should be borne in mind. The uterus lies deep in the abdominal cavity, and the tubes likewise are deeply placed. They are in intimate contact with the peritoneum. Any inflammation of these viscera quickly spreads to the surrounding tissue, and, because of the abundant lymphatic supply, the area of involvement is much greater than is apparent. This is the reason that the tenderness is much more extensive in these inflammatory conditions than one would expect from the type of lesion.

A method of eliciting abdominal tenderness in tubal disease is to make pressure with the hand, with a slowly progressive, downward motion, in the iliac fossa, so as to pinch the tube and ovary between the hand and the pelvic wall. As soon as the ovary and the tube are caught the patient makes an outcry, and the lower segment of the rectus muscle becomes rigid. This sign cannot always be elicited, for in some cases rigidity of the rectus is so great that it is impossible to press the hand into the pelvic fossa. A method of making use of the observations of Mackenzie, that "the muscular tissues" and of Lennander that "the subperitoneal tissues" are tender in visceral disease, is to place the hand palm downward on the upper part of the thigh, and then, with the fingers slightly flexed and depressed into the flesh, to draw the hand upward over the abdomen. As soon as the fingers pass above Poupart's ligament, and a drag is made upon the abdominal muscles and peritoneal tissues, the patient complains of pain. These signs are only confirmative of other symptoms and are not to be considered of pathognomonic value.

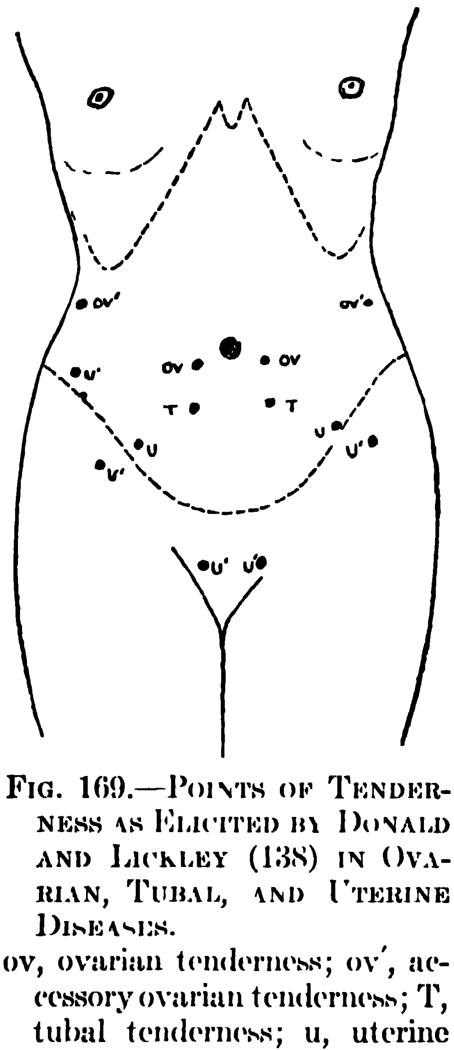

Fig. 169.—Points of Tenderness as Elicited by Donald and Lickley (138) in Ovarian, Tubal, and Uterine Diseases.

ov, ovarian tenderness; ov', accessory ovarian tenderness; T, tubal tenderness; u, uterine tenderness; u', accessory uterine tenderness.

In this connection, the areas of tenderness, as found by Donald and Lickley (138, p. 434) in pelvic visceral disease, are of interest. They found that, by pinching the skin between the fingers, or by making slight pressure upon it, certain areas or points were more sensitive than others. Each of these areas seems to have a certain definite relationship to a visceral organ. The area connected with the ovary is slightly below the umbilicus, and about two inches to one side of the median line. It lies on the intersection of a line joining the umbilicus to the anterior superior spine, with a line lying on the outer border of the rectus. At this point the eleventh dorsal nerve pierces the sheath of the rectus and becomes superficial, so that, because of its exposed position, pressure may easily be exerted upon it. There is also found an associated area of tenderness on the lateral wall, at the point where the lateral cutaneous branch of the eleventh nerve becomes subcutaneous. The area associated with tubal disease is found at the intersection of the horizontal line joining the two anterior spines with the outer margin of the rectus sheath. It corresponds to the point of emergence of the twelfth dorsal nerve.

The uterine area is located over the inguinal ring.[1] At the internal ring the ilioinguinal nerve enters the canal and becomes superficial. Other areas of tenderness associated with the uterus are: (1) immediately below Poupart's ligament, where pressure on the anterior crural is painful; (2) an area extending from the outer margin of the erector spinæ muscle to the gluteal region, following the posterior divisions of the first three lumbar nerves (this area generally is associated with disease of the body of the uterus); (3) in some cases also there is a tender area over the sacrum from the second sacral vertebra to the coccyx. This area extends laterally, and in extent corresponds to the posterior primary divisions of the mid-sacral nerves, and may be present in diseases of the cervix uteri.

The most responsive of all these areas to disease of their associated organs is the ovarian, while the uterine area is the least responsive.

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[1] Regarding the cause of tenderness at the internal inguinal ring, two theories are given: (1) the mechanical, and (2) the reflex neurological. In regard to the former, the points apparently in its favor are the dragging nature of the pain, and its location at a point where the broad ligaments are inserted. This would be of considerable value if, in all cases in which the pain is present, a dragging on this section of the abdominal wall were made by the broad ligaments, or if, in all cases in which dragging is found, pain were present. Many examples of each of these states without pain production at this point can be found, and their profusion rather negatives the value of this deduction. On the other hand, it has been found that electrolysis of the uterus will produce pain in this same area, without any general disturbance of relationship of the other organs. This would indicate that if, in all cases, the pain is not produced reflexly, at least in every case it is capable of being so produced.

A bimanual vaginal examination should be made on every patient who complains of pelvic pain. Often the tube can be felt through the abdominal wall to be enlarged and tender; even tenderness of the ovary can sometimes be elicited. When pressure is made upon either of these, reflected or referred pain will be felt in the cutaneous areas associated with them. During the vaginal examination the fingers in the vagina should push the cervix from side to side. If the adnexa of one side are diseased, pain is complained of in that side. In case of adhesions pain is produced when the position of the uterus is such that the adhesions are put on the stretch. Acute inflammatory conditions are painful either on pressure or on traction. The pain is felt on the side manipulated, and is produced either by pushing or by rotating the uterus toward the opposite side or by pressing it against the diseased tissues. Rotation of the uterus may be accomplished by using the cervix as a fulcrum to make pressure in the direction opposite to that in which it is desired to have the uterus turn. Pain on drawing the cervix forward and downward may be due to a short, sensitive, uterosacral ligament (Novak), inflammation of the parametrium, or recent uterine adhesions. According to Garrigues (163) pain is produced at the side of the second sacral vertebra by pressure on the corresponding uterosacral ligament.

Diagnosis of Pelvic Diseases.—Of value in the diagnosis of pelvic diseases are:

(1) The history of the case, which should always be carefully reviewed. The manner of the onset of the present symptoms and their duration should be defined. It should also be determined if they came on after a suspicious intercourse. Yet the absence of such a history should not be of too great influence in the forming of a diagnosis. For in many cases of pelvic disease, gonorrheal in origin, the patient has innocently acquired the coccus from an impure husband, and does not know of her affection, so that a negative history is but of slight value in forming

[illegible] opinion. In others puerperal sepsis is the cause of the trouble. What proportion of pelvic lesions come from other causes than the above is rather hard to decide, but the common opinion is that it is very small. The non-specific lesions causing pain are tumor, tuberculosis, etc.

(2) After a history of the onset a good description should be obtained of (a) the character of the discharge, and (b) the type and character of the menstrual flow. In specific infection the vaginal discharge generally is thick and creamy, and if the disease has to any extent invaded the uterus is usually of a foul odor. A mixture of blood may indicate (unless it occurs at the menstrual time) an endometritis or extrauterine pregnancy. A slight whitish discharge before or after the menstrual period is of no diagnostic value, as it is a common occurrence in many normal women. The vaginal discharge should always be examined microscopically in order, definitely, if possible, to identify the causative germ.

Because it is so common, and occurs in so many ways, it is very difficult to derive any useful information from menstrual disturbance; but change in its character is of great significance in extrauterine pregnancy, cancer, fibroid, and pelvic inflammation.

As predisposing factors to the production of pain in tubo-ovario-uterine disorders may be mentioned anemia, severe or prolonged illness, depressing mental influences causing a lessened psychic resistance, and starvation. Before passing on to a more special consideration of the pain-phenomena in the special organs composing the pelvic viscera, it is well to consider in a nervous, high-strung woman the possibility of the presence of hysteria. In this condition many other criteria and indications of involvement are present—for instance, the eye phenomena and the areas of anesthesia and hyperesthesia present in other parts of the body—and even though a severe pain may be complained of over the region of the ovary (the so-called ovarian neuralgia), it is not associated with such severe local abdominal rigidity as are organic lesions of the ovaries, tubes, or uterus.

After this brief survey of the principal causes for pelvic pain and the areas in which it is found, it is well, before a more detailed description is undertaken, to offer as a caution to those who consider only the symptoms and not the patient, Novak's warning. He says: "The gynecologist must learn to look on pain as the resultant of two factors, the lesion and the patient; and in order to arrive at an intelligent appreciation of the true significance of pelvic pain he must study both these factors with equal fidelity."

UTERINE PAIN

As a slight review of what has proceeded, let it be recalled that the uterus is supplied by two sets of nerves, the cerebrospinal and the sympathetic. The cerebrospinal nerves are derived principally from the second, third, and fourth sacral nerves, and supply the lower segment of the uterus. It is owing to the stretching of these nerves in labor, and pressure upon them by cicatrices and the like, that pain is felt. Above the cervix the muscular tissue is supplied by sympathetic nerves from the hypogastric plexus. The nerves forming this plexus are derived principally from the tenth, eleventh, twelfth dorsal, and first lumbar, the third and fourth sacral, and, at times, the first and second visceral sacral segments.

There seems to be some relationship between the uterine and the nasal mucosa, for, according to Chrobak, there is "apparently a connection between the two organs, and pains of a genital type can be relieved or stopped by the application of cocain (5 to 10 per cent., a few drops on cotton) to the septum or the lower turbinate bone." He found that "labor was made less painful, and in one instance even painless." However, this might have been the result of suggestion. Yet it is a fact that smell and the genesic sensibility are connected in a variety of ways.

Character of Uterine Pains.—Uterine pain has certain characteristics, namely, it is of irregular intensity; at times it may be constant and remain so for some time; or the constancy may be interrupted by a violent paroxysm, and the pain may then assume the type of a colic. In fact, it is this colicky, cramp-like

DIFFERENTIAL DIAGNOSIS DISEASES OF OVARIES TUBES, AND UTERUS

SYMPTOMS	UTERUS	TUBES	OVARIES
History	Frequently a history of septic or gonorrheal infection	Frequently a history of septic or gonorrheal infection	**Pain is generally present since first menstruation in cases of ovarian dysmenorrhea**
Pain Character and onset	Often constant but is interrupted with paroxysms At the same time considerable material generally blood clot or membrane is discharged from uterus	Constant dull ache in loins hips or lower abdomen Worse at menstrual period	**Dull ache, worse at menstrual period.**
Course	Gradual improvement	May gradually improve	**Generally not much improvement.**
Reference of pain	Reference is to the tenth eleventh and twelfth dorsal zones (of Head)	Reference to eleventh and twelfth dorsal zones	**Reference to the tenth dorsal zone.**
Tenderness *	Not so marked if present is in median line above the pubes	May be marked if present is found in the area along the side of the pelvic brim	**Generally in the same areas as the tubal pain but more external than uterine tenderness**
Discharge, vaginal	Generally pus Blood may be present If the endometritis is of gonorrheal origin gonococci are found	May be the same as in uterine involvement because both uterus and tubes are frequently diseased at the same time	**No discharge**
Temperature	Rise in septic involvement	Rise in septic involvement	**No rise unless the ovary is involved in a septic process**

*** In any of these conditions direct tenderness is found only when the parietal peritoneum is involved in the inflammatory process.**

manifestation which makes uterine pain so characteristic. Another characteristic is its intensity, for the uterine pain is one of the most intense that the human organism endures. Especially is this true of labor pains. In most cases uterine disorder causes a pain in the back; in fact, a dragging pain in the back is said to be characteristic of uterine disorder. The pains due to disease of the uterus will not at this time be minutely considered. Later the different pains and the factors producing each will be discussed.

The disorders of the uterus causing pain are: (1) neuralgia, (2) displacement, (3) functional acts (as menstruation, pregnancy, and childbirth), (4) inflammation (as endometritis, metritis, peri- and parametritis), and (5) new growths.

Neuralgia.—Neuralgia of the uterus is often (as was said when the term was used in speaking of pains in other organs) but a cloak for ignorance. That neuralgia may occur in the uterus, the same as in other organs, cannot be doubted; but, even so, the term is generally used by the attending physician to hide his lack of diagnostic skill. A diagnosis of neuralgia should be made only after a negative search for lesions of sufficient gravity to cause the pain. Neuralgia is frequently a term wrongly used in speaking of the pain due to endometritis, etc.

Displacement of the Uterus.—Displacement of the uterus, of itself, does not produce any severe pain, though it is frequently the cause of the aching in the back, so common in this disorder. This aching is due to two factors: (a) the drag upon the ligaments attaching the uterus to the pelvis, and (b) the congestion of the uterus from partial obstruction to the return blood flow in the broad ligaments. The displacement, of itself, produces a direct pain, localized in the tissues deep in the back. Unless congestion is excessive the pain, the result of displacement, disappears on replacing the uterus in the normal position. However, if the congestion is excessive the pain does not disappear so readily on the correction of the mechanical defect, because it takes time to eradicate the changes which have taken place in the structure of the uterus following a long-continued congestion, and which have been acting as causative factors of pain production. When congestion and structural changes occur, sensory disturbances in Head's zone also appear, and persist until recovery has taken place. In some cases, where the uterosacral ligaments are particularly sensitive, a slight drag or pull upon them by an enlarged uterus, or by the examiner, through traction made on the cervix, will produce a very severe pain.

Character of the Displacement Pain.—Displacement produces more of an aching in the back than an actual pain. In some cases, where the displacement is excessive, as in complete prolapsus, traction may be made upon some of the nerves arising from the sacral plexus. When this happens pain occurs in the distribution area of these nerves (sacral plexus). In fact, under such circumstances, any of the nerves passing through the pelvis may be interfered with and pain be produced. The pain of displacement is made worse on walking, especially should the displacement have been transformed into a prolapsus. The pain in retrodisplacement is eased only by lying on the abdomen and is increased by lying on the back, while in prolapsus, ease comes on lying down in any position. On the other hand, all changes of position are painful if adhesions bind the uterus to adjacent structures. Then the pain, instead of being entirely of uterine origin, is modified by that due to disturbances in other closely related organs. Antero-displacement is not as painful as retrodisplacement, possibly because the anterior displacement occurs in younger people in whom the pelvic structures have not been injured by childbirth, and in whom other associated changes are not so likely to be present. In retrodisplacement defecation is sometimes painful, while in displacements of the anterior type there are often both complaint of pain during defecation and a frequency of urination. In anterior displacements there may also be a sense of pressure or of aching behind the symphysis pubis.

Displacements are among the common causes of dysmenorrhea (Herman, Kelly). In displacement there often is an angulation of the cervix, so that, during the menstrual period, the blood and membranes are not so easily discharged, because of the narrowing of the canal, due to the angulation. As a consequence, the menstrual discharge from the uterus is hindered, and uterine colic results.

Functional Disorders of the Uterus.—The principal functions of the uterus are menstruation, pregnancy, and childbirth. The first two should be painless; but unfortunately, as a price of our higher civilization, the woman finds that frequently, instead of these being periods of well being and content, they are, because of the frightful pain and distress which she suffers, periods of dread and dismay.

MENSTRUATION.—Among savages, menstruation is generally without pain, and even among those of higher civilization it is frequent to find the menses coming on without distress. Yet, as civilization advances, and our women mount the ladder of indolence and ease, pain and distress gradually become more and more pronounced, until, at the summit, in our latter-day civilization, woman is incapacitated for a greater part of her time by conditions which ordinarily should cause but slight, if any, inconvenience.

Painful menstruation is termed *dysmenorrhea*. Holden analyzed the histories of one thousand consecutive cases of abnormal pelvic conditions with reference to the occurrence of this symptom. As the result of his observations he presents the following conclusions:

"Dysmenorrhea is present in 47 per cent. of all gynecologic hospital patients. In about 23 per cent. of the entire number it seems to be definitely caused by certain abnormal conditions of the pelvic organs. In 22 per cent. of the entire number it is present in conjunction with such conditions, but is apparently not caused by them. The pathologic conditions which are most frequently seen as the causes of dysmenorrhea are: (1) retrodisplacements of the uterus, (2) pelvic inflammatory disease, and (3) myomata. These three conditions account for nearly 90 per cent. of all the dysmenorrhea which is caused by pathologic conditions of the pelvic organs. Retrodisplacement accounts for 41 per cent., pelvic inflammatory disease for 37 per cent., and myomata for 11 per cent. Of nulliparous patients with retrodisplacements causing symptoms, 86 per cent. have dysmenorrhea. The frequency of this association leads to the conclusion that the abnormal position causes the dysmenorrhea. In retrodisplacements occurring after childbirth it is much less common; 25 per cent. of multiparæ with retrodisplacements have dysmenorrhea, which is apparently caused by the malposition. Of all the patients with pelvic inflammatory disease, 31 per cent. have dysmenorrhea, which is apparently caused by the condition. Of all the cases of myoma, 20 per cent. have dysmenorrhea apparently caused by the tumor."

During the normal menstruation the uterine muscles undergo a slight contraction, but not of sufficient strength to be felt as such (Winter, Menge). The factors that would cause the normal contraction to become abnormal, either in regard to the time or the strength of the contractions, are: some hindrance to the expulsion of the menstrual blood (as a contracted os uteri), an inflammatory thickening of the endometrium,[1] or a faulty position of the uterus in which it is flexed and the cervical canal is angulated. Stenosis of the external os is not as frequent a cause of pain production as is stenosis of the internal os. Winter says that he has occasionally seen collections of blood behind the external os sufficient to cause ballooning of the cervix without causing the least pain.

Dysmenorrhea, when due to *cervical stenosis* or angulation from whatever cause, is generally relieved by pregnancy. If the dysmenorrhea be entirely mechanical, or be due to some structural defect (either a narrowing or contraction of the cervix, or an angulation of the same from a faulty position of the uterus), it is found that the menstrual pain dates from the period of the first menstruation or from the time of some operative interference. It is very characteristic, in that it begins only a very short time, a few hours, before the blood commences to flow, and continues as long as the blood flow is active, and then ceases as abruptly as it came on. All other forms of dysmenorrhea generally start a day or two previous to the flow, and are the result of the pelvic congestion incident to the flow. If anteflexion is suspected as the cause of the dysmenorrhea, to make the diagnosis certain it is necessary that there should be present a freely movable, normally developed uterus, in permanent, rigid anteflexion, in a person who is neither nervous nor hysterical (Winter).

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[1] Theilhaber claims that 25 per cent. of all cases of dysmenorrhea are caused by a stenosis of the cervix, either congenital or acquired. Theilhaber also claims that in hysteria a contraction of the circular muscular fibers of the cervix may occur, causing a stenosis and consequent pain.

In some cases congestion of the endometrium, incidental to the menstrual flow, may block up the cervical passage, and the expulsion of the uterine contents is difficult.

Spasmodic contraction of the cervix is a frequent cause of uterine pain. This spasmodic contraction, according to Herman, is due to the fact that the uterine center in the cord, or in the sympathetic system which regulates the movements of the genital canal, is imperfectly developed. The vagina, uterus, and Fallopian tubes are muscular organs like the intestine. During the sexual orgasm there is coordinated muscular action of these organs, the object being to help the ovum from the tube and the spermatozoa from the vagina into the uterus. In a normal, painless menstruation there is also a coördinated action, the body of the uterus contracting and the cervix dilating, so that the menstrual flow is expelled without pain or difficulty. In this neurotic variety of dysmenorrhea the natural dilatation, because of changes in the cord or sympathetic ganglia located in the cervix, is absent; and as a consequence the contractions of the uterine body are morbidly violent and painful. The only physical sign observed in these cases of dysmenorrhea is difficulty in dilating the cervix.

Another cause of dysmenorrhea is hindrance to the separation of the decidual membrane. Owing to degeneration or disease the endometrium may be difficult to separate entirely. Parts of it, not being entirely free, lie loose in the uterine cavity, and may cause repeated and violent contractions of the uterus. *Endometritis* is one of the most common causes of this condition. *Membranous dysmenorrhea* gives rise to large, free masses of membranous tissue in the uterine cavity, and it is the effort of the uterus to expel them which probably causes pain.[1]

Endometritis dolorosa is the name given to an endometritis in which severe pain is present; but here again the pain is due to a compression of the uterine nerves, for as soon as a dilatation of the cervix is performed the pain vanishes (Sneguereff).

Maldevelopment of the uterus acts as a cause of pain during menstruation. In these cases the uterine cavity is so small that during menstrual congestion the two walls become so swollen that they completely block up the opening and the blood and menstrual débris cannot be discharged. Winter accounts for this form of dysmenorrhea as the result of reflex contractions of the uterine musculature, the reflex in turn being the result of increased pressure in the uterine vessels; the increased pressure being due to the facts, that the vessels are too small to allow for the accumulation of the blood, and that the cavity of the uterus is too narrow to permit the necessary degree of swelling of the mucous membrane.

Hyperesthesia of the muscles (uterine) and of the uterine mucous membrane may also be present. These may cause contraction of the uterus during menstruation, when otherwise the menses would have been normal. Such is the case in those individuals of a neurasthenic nature, in whom we so often find a marked dysmenorrhea. Very frequently this variety of dysmenorrhea is also found in those of reduced vitality.

It may be that in some of these patients the receptive state of the nervous system is also in a peculiar irritative condition in which it responds to lighter stimuli than ordinarily would affect it.

In cases of this character the pain is not relieved on lying down, as it is when the dysmenorrhea is of congestive origin. It generally begins with the flow and is of very short duration. The

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[1] Painful areas, present in one case, were (Sneguereff) the tuberosity pubis on each side, the inner surface of the thighs, the renal plexus on both sides, the solar plexus, the rectum (?) and the anterior superior spine. Perineal areas were the emerging point (1) of the ilioinguinal, (2) of the sup. int. cutan., and (3) of the pudic.

DIFFERENTIAL DIAGNOSIS OF DYSMENORRHEA

SYMPTOMS	CATARRHAL	GONORRHEAL	SEPTIC	TUBERCULOSIS
History.	Generally a history of acute infection, frequently gonorrheal, with subsidence of the pain but with the persistence of a thin secretion.	Of an illicit intercourse or occurs in a wife whose husband is suffering from gonorrhea, either the active or old chronic variety.	Generally follows abortion, parturition, intrauterine sounding, or the intrauterine use of other instruments. May occur independently of these.	A history of tubercular infection; other structures may be involved, though in many cases a history of tuberculosis in any form is absent.
Onset.	Follows the acute variety or may develop insidiously.	Generally acute.	Generally acute. Comes on quickly after the infection.	Very slow.
Uterine bleeding.	None.	May be present during the early stages.	Common.	Common, late in the disease.
Discharge.	Generally clear mucus and free from germs, but contains broken-down tissue cells and pus corpuscles.	Very profuse, and in it the gonococcus may be found. May be offensive and is of a creamy white or yellow color.	Profuse. Contains the causative germ in abundance. Very offensive. It may be clear, yellow, or creamy.	Presence of tubercle bacilli (?) in the discharge or in the uterine scrapings. The discharge may be cheesy in character.
Fever.	Absent.	May be present.	Present.	May be present.
Course.	Essentially chronic.	Acute stage soon passes off, then it may become catarrhal.	May be rapidly fatal. If not, it drags on for weeks and becomes chronic.	Very chronic.
Pain.	Absent on sounding and, subjectively, is present only when the secretion collects to a considerable degree. Tubal inflammation is very common.	Frequent in the acute stage. Is more an aching and discomfort in lower abdomen, though it may become an actual pain.	Pain is generally due to involvement of the adjacent peritoneum.	Generally absent, until the metrium and perimetrium are involved; then localised and referred pain is present.

DIFFERENTIAL DIAGNOSIS OF DYSMENORRHEA—*Continued*

SYMPTOMS	NEUROTIC DYSMENORRHEA	MEMBRANOUS ENDOMETRITIS	FUNGOID ENDOMETRITIS	DECIDUAL
History.	The pain may date from the first menstruation or it may come on after years of painless menses. After it once commences it is seldom relieved except by operative means or by pregnancy.	History not especially characteristic.	History of bleeding.	History of present pregnancy. History of an endometritis present before pregnancy began.
Onset.	Generally sudden. May follow after years of normal periods.	May be acute or gradual in its onset.	Slow and gradual in its onset.	Occurs in the early course of pregnancy and persists for three or four months.
Uterine bleeding.	Not marked.	Not marked.	Very common.	Absent. Sometimes is present.
Discharge.	Discharge of any kind may be entirely absent.	Membranous shreds, or even casts of the uterus; are thrown off during the last stage of the menstrual discharge.	May be present.	Serous and at times bloody.
Fever.	None.	Absent.	Absent.	Absent.
Course.	Pain disappears after menstruation.	Chronic.	Chronic.	Symptoms generally disappear in the latter half of pregnancy.
Pain.	Occurs generally at the time of the menses, and is most severe. It also may occur at intermediate periods.	Very severe, being especially marked at the end of the menstrual period, at the time of the separation of the membranes.	No pain, subjectively or on sounding.	Resembles labor pain. Abortion or miscarriage sometimes occurs.

individual spasm lasts about one minute and recurs with about the frequency of labor pains. This type often arises after years of painless menstruation.

Polypoid growths inside the uterus may, by hanging down, obstruct the cervix, and thus, by a ball-valve action, be a cause of pain.

Ovarian dysmenorrhea is a term used to define the pain produced in the ovary from the congestion incidental to menstruation. It occurs before the flow commences and ceases as soon as it becomes profuse.

Possibly a *fissured* state of endometrium at the internal os may also excite such a spasm of the uterine musculature as is produced in the sphincter in anal fissure. A spasm of this type is increased by congestion of the tissues. It is given as a cause of pain by Keating and Coe.

Winter, after a careful review of the subject, gives the following very clear conclusions in regard to menstrual pain, namely, that it is necessary, in order that the natural process may run a painless course, that "nothing interfere with maturation and rupture of the follicles; that the congestion in the uterine wall does not meet with resistance from infiltration of the tissues; that the mucosa be capable of swelling and of taking up the extravasated blood; that the size of the uterine cavity be sufficient to accommodate the swollen mucous membrane; that the menstrual blood escape readily from the cervix, and that the congestion of the tubes and of the peritoneum take place in normal tissues. In addition the nervous system must possess a normal degree of irritability and the psychic function must be normal; otherwise the slight alterations which take place in the nervous system during normal menstruation may be abnormally exaggerated" (Winter, Clark's translation).

Referred hyperalgesia in the uterine segments is very common in all these conditions which produce uterine pain. Pain in the breasts is also a frequent accompaniment of menstruation. It generally precedes the menstrual discharge by a few days. Because of this breast pain, breathing may be painful.

In résumé, it may be stated that menstrual pain may occur before, during, or after menstruation. When it occurs (1) before menstruation, it is due to hindrance to the discharge of blood from the uterus because of (a) narrowing of the lumen of the cervix, the result of a stenosis which has taken place from a chronic inflammation of the endometrium, or from an angulation of the cervix, from a flexion of the uterine body on the neck; (b) blocking of the lumen of the cervix by a blood clot or by a piece of endometrium; (c) obstruction to the menstrual discharge by a foreign body (as tumor); and (d) chronic inflammation of the ovary, which has caused a thickening of the tunica albuginea, so that the Graafian follicle, because of the thickness and toughness of this layer, has great difficulty in penetrating to the surface; congestion results, and this stretches the peritoneal coat and causes pain; (2) during menstruation, it is generally due to chronic endometritis; and (3) after menstruation, it is due, as a rule, to inflammation of the adnexa.

Intermenstrual pain is the name given to a pain which generally comes on about the middle of the mid-menstrual period. It usually lasts for two to four days, though it may persist till the next menstruation. Several theories have been advanced as to its causation. Among the most reasonable are:

(1) That it is due to the retardation of the outward passage of the Graafian follicle toward the periphery, by some change in the ovarian stroma; the resultant congestion and tension producing pain.

(2) That in cases of ovarian adhesions the pain is due to the traction made on these adhesions by recession of the ovary after each menstrual period. This recession necessarily reaches its climax about the middle of the intermenstrual period (Reed).

(3) Circulatory changes in the ovary, causing ovarian congestion, may also produce intermenstrual pain (Sheill).

The pain resulting from these factors may vary from a dull ache to one of great intensity. It is generally reflected to the ovarian region, on one or both sides, or it may be felt alternately on either side. "It comes on about the twelfth to the fourteenth day after cessation of the menses. It lasts for a day or two, is often accompanied by a discharge of clear fluid, and is followed by a period of rest or complete cessation of pain up to the onset of the next period" (Addison). Change of position does not influence the intensity or character of the pain. On examination, in many cases, no lesion can be found.

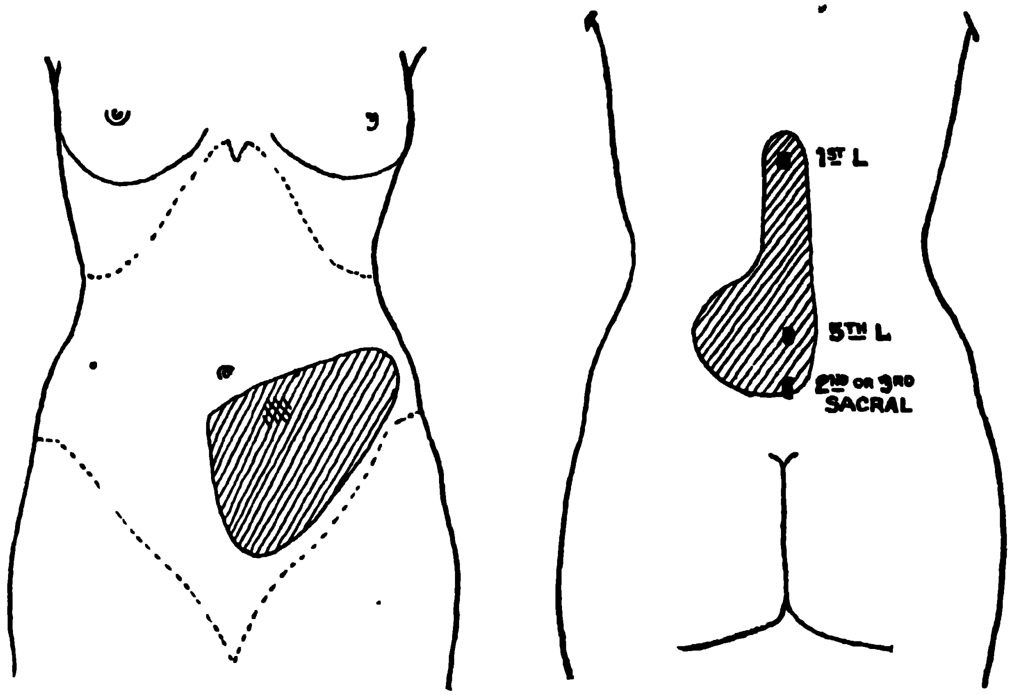

Fig. 170.—Areas of Hyperalgesia in a Woman Two Months Pregnant. They represent the 10th and 11th dorsal zones of Head. The maximum point of tenderness is in the 10th dorsal. The zones did not extend uninterruptedly around to back. Tenderness and hyperalgesia were present over the corresponding spines. These areas of hyperalgesia very likely are due to traction exerted on the ovary and tube of the left side by adhesions.

Pregnancy.—In a normal woman pregnancy is entirely free of pain; yet, it is common for the physician to be troubled by the complaints of his patients who are with child. The causes of pain during the gravid state are:

(1) Pressure upon adjacent and associated organs, as the tubes, or ovaries; (2) traction on adjoining structures by adhesions; (3) the weight of the organ itself, which, even though normal, may drag upon neighboring structures and produce discomfort and distress; (4) in some cases, the projection of a fetal part

into the uterine wall; (5) intestinal coils may drop beneath the uterus, causing a partial strangulation; (6) should the ovary be cirrhotic, the corpus luteum, when it begins to enlarge, is compressed by the nondistensible connective tissue, and dull, aching pain in the ovarian zone results; (7) partial obstruction to the bowels may occur during pregnancy, owing to some of the intestinal coils being caught between the uterus and the surrounding parts; (8) obstruction to one or both ureters may occur from pressure by the uterus, and thus hydronephrosis, with its consequent pain, may result.

The case given below illustrates the production of pain due to a partial obstruction of the bowels. It might, also, be taken as an example of pains produced by ovarian and uterine congestion, the pains early in pregnancy being due to the congestion, the colicky attacks, later in the pregnancy, being the result of intestinal colic. The early pains of which the patient complained began about the second week of pregnancy and continued intermittently. They were colicky in type and were located in the lower abdomen. The individual attack was produced by the patient's moving, especially by her turning on the right side. During the attack she was doubled up, with the knees flexed, and the abdomen was tense and rigid. The hands were clinched and were pressed tightly into the suprapubic region. The face was drawn and the eyes closed. The individual attacks lasted about three minutes.

These colics appeared at irregular intervals, ranging from a few days to one week; sometimes they appeared more frequently, several in a day. After being present for six weeks, they disappeared and the patient then had neither pain nor colic. A vaginal examination disclosed a retroflected, enlarged uterus, about two months pregnant. The attacks ceased when the uterus rose above the pelvic brim.

It is just possible that in this patient a part of the intestine had been caught under the displaced uterus, and that its lumen was constricted, the severe colic of which, at times, the patient complained being due to the effort of the intestine to force its contents beyond the constricted portion.

CHILDBIRTH.—Like menstruation, childbirth naturally should be a painless process. It is only as culture advances

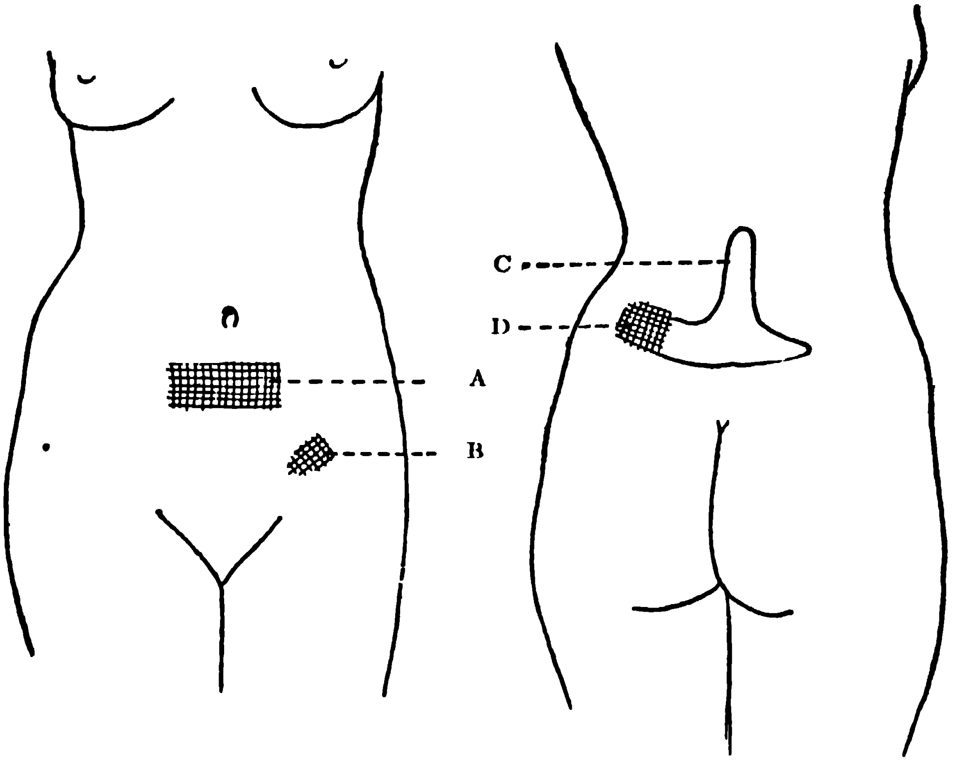

FIG. 171.—PHENOMENA ACCOMPANYING TUBAL DISORDERS.

The uterus was at this time above the pelvic brim and the ovary was free of its compression, yet the tube in the meantime evidently has become injured and caused the above phenomena Hyperalgesia was absent. A few weeks after the above phenomena was defined, all pain and discomfort ceased, and the patient had a normal delivery

A—Area of local tenderness, also area of pain to deep pressure. Superficial pressure is not painful, neither is muscular pressure.
B—Area of maximum tenderness to deep pressure.
C—Area of pain to deep pressure
D—Area of maximum tenderness.

that the labor becomes painful, for in women of primitive races pain is absent. Savages of a low degree of civilization are generally but little troubled by parturiency. The reason is that, although among primitive people the contractions of the uterus are as severe during childbirth as they are among civilized races, yet, because of the easy dilatation of the cervix,[1] they do not

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[1] Why this should be is as yet unexplained.

suffer pain. Among observers it is generally agreed that pain of uterine contraction is not due to the contraction of the muscle itself, but is the result of the restraint of this functional activity by cervical obstruction. This cervical obstruction is not so prominent among primitive people; therefore they have less pain. When dilatation of the cervical segment occurs easily, pain is absent.

At the present time, though rare, pain may be entirely absent during labor. Allen explains this absence of pain as being due to the relaxation of the parts by nature, while Young claims that sometimes at the acme of labor there is a physiological anesthesia. A peculiarity that has been noted of the pains occurring during labor is that, instead of being in the normal locations, they may, as in a case seen by the author, be radiated from the thigh to the knee. In this case the pains were excruciating and occurred synchronously with the uterine contraction, as was verified by abdominal palpation. In this respect the words of Granville, whose remarks hold true to-day, may be quoted. He says:

"Sensations of pain experienced by the parturient woman are not invariably synchronous with what, for want of a better name, we term the *pains of labor;* and from this and other premises, for example, the circumstance that they are commonly referred to regions more or less remote from the contracting uterus, or the dilating external passages, in which the real seat of pain might have been supposed to be located, I deducted that the pain attendant on labor is neuralgic in character."

Labor pains, when present, are as a rule first felt as a dragging or aching in the back, low down in the lower lumbar region. In some there is present a sensation as though the back were breaking. At this time (the first stage of labor) the pain corresponds to the early stages of cervical dilatation. Later, when the uterus commences to contract and the cervix begins actively to dilate, pain is felt over the sacrum and coccyx in the second, third, and fourth sacral areas, and sometimes in the first and second sacral areas (Head). When the cervix has dilated, and the contractions are forcing the head through the pelvis, the referred pains are felt in the tenth, eleventh, and twelfth dorsal and first lumbar areas. These are the areas in which pain is felt post partum, when the uterus is forcing out of its cavity the residual clots.

After labor and during the puerperium, if subinvolution should occur, a feeling of weight and of dragging is felt in the pelvis.

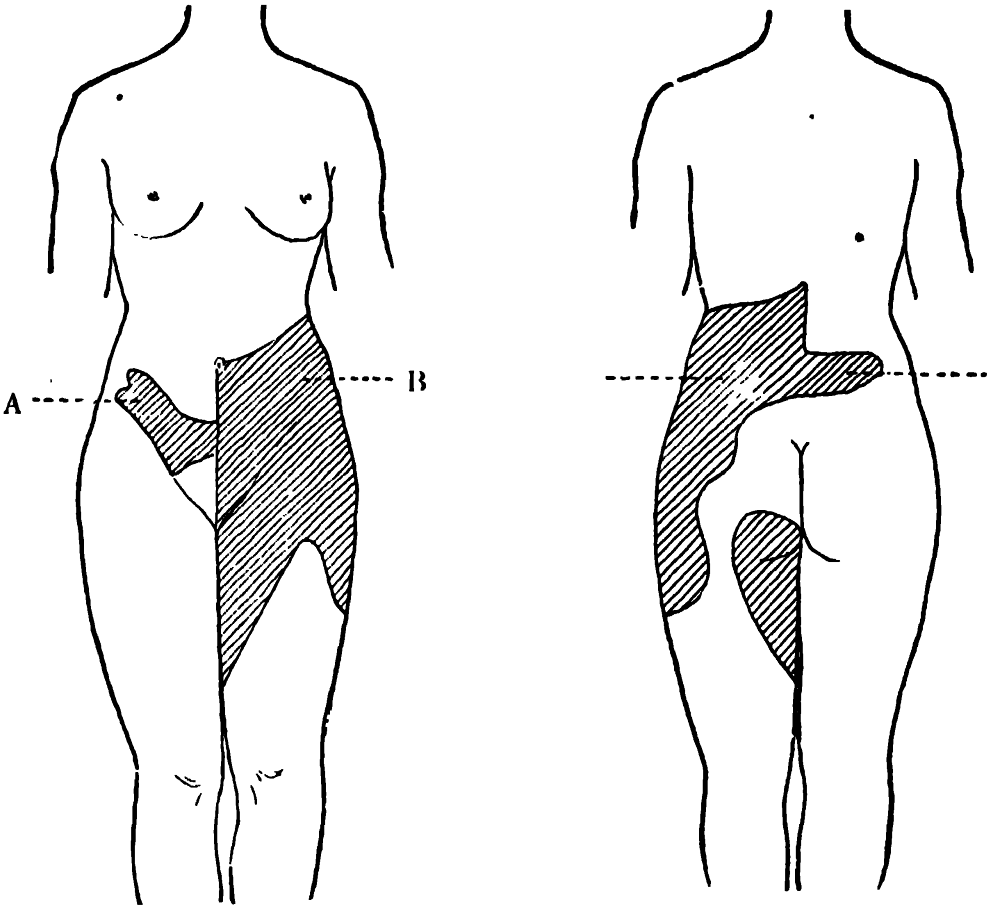

FIG. 172.—AREAS OF REFERRED PAIN IN A CASE OF LABOR. (Head.)
A—Dilatation in the second stage of labor. The pain is in the 11th dorsal segment and is due to contraction of the uterus.
B—Hyperalgesia is present in the 10th, 11th, 12th dorsal, 1st lumbar and 3d sacral, posteriorly present after the effort of the uterus to expel post-partum clots.

Inflammation of the Uterus.—Inflammation may occur in the lining structure (endometrium, endometritis), the contracting portion (metrium, metritis), and the inclosing structures (peritoneum, broad ligaments, peri- and parametritis).

Endometritis.—A pronounced inflammation of the endometrium can hardly take place without involving the next adjacent structure (metrium), so that the pain due to a severe endometritis partakes more or less of the character of the pain due to a metritis, and if the inflammation is severe and involves the peritoneum, the pain has also the characteristics of that due to peritonitis. Ordinarily, the endometrium has no pain nor touch sensation, but when inflamed it becomes very sensitive. This is of great diagnostic value, and tenderness (endometrial) should be searched for in endometric inflammatory states. This tenderness may be demonstrated by means of a sound (Winter).

The sound must not be too large, and should be carefully introduced through a previously dilated cervix, and search should be made for the sensitive spots. When the sound touches such a spot the pain may be so severe that the woman "cries out, shrinks from the sound, or faints." Should pain be severe only on the introduction of the sound, and on moving it with sufficient force to disturb the relations of the uterus to the surrounding tissues, and not present on gentle manipulation, peri- or parametritic inflammation should be diagnosed. That the endometrium has pain sensation in a normal case can hardly be admitted (Rothrock), though in the presence of inflammation, the adjacent layer may be so involved by the inflammatory process that it becomes irritable and responds to any irritation with a sensation of pain. It is noticeable that the pain sensation in endometritis of ordinary severity is never localized to the area of its production, but is always referred; but should the inflammation be severe, and perimetritis result, and the peritoneum become involved, especially if the inflammation occurs near the cervix in the area supplied by the spinal nerves the pain is localized to the area of its production.

Endometritis also causes pain, having somewhat the characteristics of labor pain; this pain is caused by the same factors that produce labor pains, namely, the contraction of the uterine muscle, excessive in the endeavor to force foreign material from the cavity of the uterus. The pain is most severe at the time of the menses, though it does not necessarily appear at this time, but may come on at any time that the secretions collect to such an extent that, in the presence of a stenosed cervix, their expulsion requires forcible uterine contractions which are very painful.

The pain of endometritis is worse on standing than on lying down. Tenderness on palpation is not present unless the metrium and the surrounding tissues are involved. When this occurs, abdominal and bimanual palpation are very painful. If peritonitis has set in, pressure in the pouch of Douglas produces severe pain. Likewise, rectal palpation is very painful.

Later, as a result of these inflammatory states, adhesions form and pain results from their drag and pull. The areas of reference of these pains have been described.

CERVICITIS.—Erosions of the cervix cause pain either through the sympathetic or the cerebrospinal systems. When the sympathetic is involved, the pain is referred to the area of distribution of the second or third sacral segments, but when the cerebrospinal is involved the pain is referred generally through the branches of the pudic to the perineum, or to the bladder. When the latter reference occurs, there is painful and frequent urination. The involvement of adjacent nerves is probably the result of a lymphangitis which has spread from the erosions into the periuterine fascia.

DIAGNOSIS OF ENDOMETRITIS.—The following, which are generally present, may aid in the diagnosis of endometritis:

(1) Hemorrhage; eliminate carcinoma, myomata, and tubal inflammations, all internal disorders producing it, or local circulatory derangements, such as extrauterine pregnancy, obstruction to the return flow by tumors, etc., and it is safe to say, in the absence of menstruation, that it is due to endometritis.

(2) The pain of endometritis is somewhat characteristic in that it is much worse at the time of menstruation.

(3) Discharge of inflammatory products and endometrial shreds from the uterus. The variety of endometritis is decided by the history, the onset, the discharge, and the course.

Ulceration of the cervix, unless it is deep and has produced a pelvic lymphangitis, causes no local pain, but a reflected pain is felt in the region over the sacrum and the coccyx and is frequently localized to a spot immediately dorsal to the anus. This spot is also very tender to the touch.

Metritis.—In inflammation of the muscular layer of the uterus pain may be due to the contraction of the uterine muscles, or to the irritation of the nerve terminals by the toxic products of the inflammatory process. It may also be due to the pressure exerted upon the terminal nerve filaments by the inflammatory products. These pains are referred to the zone areas associated with the uterus (see Fig. 168). Another cause of pain production is the spread of the inflammation to the peritoneum with involvement of the parietal layer. These causes are active only in the acute cases, for as a rule chronic metritis is without pain (Theilhaber).

New Growths of the Uterus.—New growths are either benign or malignant. *Benign growths* are not painful unless they block the cervical canal; when, during contraction of the musculature, pain of the type of a labor pain is felt. This pain persists in rhythmical periods until the mass has been expelled or until the canal has become free. The pain, naturally, would be greater at the time of the menstrual periods. Growths may also press upon adjacent structures and interfere with their function and so cause pain. They may also press upon the lumbar and sacral nerves and cause pain which is referred to the peripheral distribution of these nerves in the back and legs (Donald and Lickley). Pain due to pressure from growths, as a rule, is constant.

Malignant growths toward the end are always painful, but early in their course are usually free from pain. Pain occurs only when the growth makes pressure upon the surrounding structures, or interferes with the emptying of the uterus, or when the tumor cells invade the nerve trunks. Kundrat has shown, in the case of carcinoma, that the nerve trunks become infiltrated with cancer cells. In other cases pain may be due to the absorption of toxins or to the extension of the inflammatory growths (Rothrock). In all these conditions, when the growth is in the fundus or deep in the cervix, referred pain in the skin area, associated with the particular part of the genitalia involved, is present. Should the cervical canal become obstructed, typical uterine colic pain appears. Pain seems, when present, to be more often felt on the left side (Champney).

Fibroids of the uterus are fairly common. They announce their presence by two varieties of pain: (1) a periodic pain which appears before each menstrual period and is relieved by menstruation, and (2) an intermittent pain, which, in the case of intrauterine fibroids, accompanies the menstrual flow. It may also appear at other times. Some fibroids have also been known to extend into the pelvis, and, by pressing on the lumbar and sacral plexis, to give rise to pain in the distribution areas of the involved nerves. The great sciatic is most frequently affected, and pain in its distribution area is common (Wilson, 361).

In cancer of the uterus, out of sixty-seven cases pain was the first symptom to appear in twelve (Craig); leucorrhea, in forty-five, and hemorrhage, in twenty-two.

FALLOPIAN TUBES

Pain due to disease of the Fallopian tubes may result from (a) distention of the tubes; (b) inflammation of the tubes; (c) adhesion of the tubes to neighboring structures.

Tubal Conditions Causing Pain.—All who practise medicine, and particularly surgeons, are familiar with hydrosalpinx, a condition in which the Fallopian tubes contain a considerable amount of clear serum. In these cases the uterine and the fimbriated extremities of the tubes are blocked, so that it is impossible for the fluid to be discharged. Pain may follow this stagnation, though the swelling in many cases reaches a considerable size before its presence becomes intolerable; in fact, it may never cause pain. Yet, because of the pressure exerted upon adjacent structures, or because of the active inflammation which is present, pain is frequently a prominent symptom. If the pain be due to dragging or to pressure on adjacent structures, it may be eased by the patient's assuming a counter-posture. If it be due to inflammation, the increase in pulse rate and elevation of temperature will help to define the lesion. When the tube is inflamed, the resulting pain is either reflected (Head zone, see figure) or is localized to the area in which it is produced. In the latter instance the pain is felt in the lower iliac region, and is due to the inflammation, communicated to the parietal peritoneum from the diseased tube. It is of a burning, stabbing character, and may be very severe.

If the pain is the result of an acute hyperemia, it is of a throbbing character, while that due to chronic inflammation is of a dull, aching type. All inflamed sensitive tissues are tender to pressure; therefore, pressure on the tubes will also be painful. This pressure on the tubes may be exerted by two methods. The first is the bimanual, by which pressure is made between one hand placed over the abdomen and the index or the first two fingers of the second hand inserted into the vagina. With the fingers in the vagina, the uterus can be rocked to either side. If on this motion pain is produced it may be surmised that inflammation is present. When the uterus is thrown to the side away from the inflamed tube, pain is the result of the traction and stretching which ensue, while if it is thrown against the inflamed tube, pain results from the pressure. The pressure of the uterus against the inflamed tube is much more painful than is the traction away from it.

Should chronic salpingitis be present, pain may be produced by grasping the tube between the examining fingers, thus making pressure directly upon it. Sometimes, in pyosalpinx, if the examination has been rough, some of the pus may be pressed out of the end of the tube, and a localized peritonitis results. This is indicated at the time by a severe pain, persisting after the examination. It may be accompanied by an elevation of temperature and a rise in the pulse rate. Spontaneous rupture of a tube through its fimbriated extremity is very rare.

In tubal inflammation all functional acts which in any way cause a changed relationship between the tubes and the surrounding functioning structures are very painful. In many, micturition and defecation are productive of much pain; indeed, they may become so painful that the patients voluntarily inhibit themselves from performing the acts. Constipation and retention of urine necessarily result. Micturition is not so painful when the inflammation is confined to the tube, but becomes extremely so when the bladder itself is involved in the inflammatory process. These disturbances produce, in addition to those already present, their own particular form of pain.

Sometimes tubal inflammation causes uterine colic (Winter and Clark). In such cases exacerbations of pain, occurring generally prior to the periods, are frequent. Should pain be present in the ovarian, tubal, and uterine areas at the same time, it indicates an involvement of all these associated structures. In a case of gonorrheal salpingitis, Saenger (362) thought the pain was due to the excitation of peristalsis by the inflammation present.

As a result of tubal inflammation, adhesions are formed and resist subsequent distentions of the tube, and are accountable for a large share of the resulting pain, particularly so if the distention is accompanied by certain functional acts that in the ordinary course of events would be painless. However, tubal swelling, alone, without the presence of adhesions, may be painful. How large it may become before it is painful depends particularly upon the local conditions. A tube in a free and clear pelvis may reach a much greater size without discomfort than if it were in a pelvis filled with pelvic exudate and bound with adhesions. In some the tube may reach the size of an orange without causing great discomfort, while in others a very small swelling will produce the utmost distress.

Extrauterine Pregnancy.—Extrauterine pregnancy (tubal or tuboovarian) may cause no pain unless a rupture or a partial rupture occurs, and bleeding into the peritoneal cavity takes place. This complication may follow a vaginal examination, or it may be the result of sudden motion or of forcible bending or flexion of the body. It is indicated by severe and agonizing pain, generally in the iliac region of the side involved, though it may be spread over the entire lower abdomen. In some cases the pain is referred to the shoulder. In these cases it is possible that the blood may extend as high as the diaphragm and so irritate it; this irritation, in turn, is transmitted through the phrenic to the supraacromial nerve, and so causes pain to be referred to the shoulder.

It is rather surprising to note the small quantity of blood which produces such a severe sensory reaction. In many cases the presence of an ounce or two of free blood in the peritoneal cavity will cause the most severe distress.

The pain probably represents the prostration of the peritoneum to the traumatism of the hemorrhage. In hemorrhage produced by the slipping of a ligature from the stump, following an ovariotomy, no pain is present, probably for the reason that the peritoneum, having already been subject to the shock and traumatism of an abdominal operation, is not capable of again responding when the hemorrhage occurs (Richardson).

Ruptured tubal pregnancy may be confused with (Crossen): (1) hemorrhage from the ovary, (2) tuboovarian hemorrhage, (3) fulminating pelvic edema, (4) gonorrheal salpingitis, (5) miscarriage, occurring in a patient who has an ovarian tumor, (6) pregnancy with hydatidiform mole, (7) rupture of a pus tube, (8) appendicitis, (9) strangulation of internal hernia, and (10) perforative peritonitis.

In extrauterine pregnancy intense, lancinating pain in the lower part of the rectum is at times complained of. The cause of this pain may be adhesion between the gestation sac and the rectum (Boldt).

OVARY

No pain is caused during pelvic examination by taking a normal ovary between the fingers and thus making pressure upon it, but a peculiar sickening sensation is experienced, somewhat of the same character as is felt by the male when his testicle is squeezed.

Local Point of Pain.—Head gives the area of cutaneous hyperalgesia for ovarian disorders as that of the tenth dorsal segment (see Fig. 173) and he mentions two points of maximum tenderness, one in the small of the back over one or more lumbar vertebræ, and the other at a point a little below and external to the umbilicus on the same side as the ovary which is at fault. It seems very odd that Morris should have called attention to this point during the past few years, as a sign of oöphoritis or of disease of the appendages. He claims that in disease of the ovaries or appendages there is a spot tender to pressure, about one and one-half inches down from the umbilicus and one inch external to the midline of the abdomen. In appendicitis there is pain on pressure at this point, but it is present only on the right side, while in ovarian or tubal disease the pain is present on both sides. Pain from the ovary has also been known to be reflected to distant points. In one case it was present in the shoulder, and ran down the left arm.

Causes of Pain.—The causes of ovarian pain are: (1) pressure from an increased cell production, (2) structural changes in the nerves supplying the ovary, (3) functional changes in the nerves by which their sensibility is greatly increased (McEvitt).[1]

Characteristics of Ovarian Pain.—Cuthbert Lockyear (307, p. 1061) gives the following characteristics of ovarian pain:

(1) It is referred.

(2) It is associated with superficial or surface tenderness.

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[1] Herman (144) says that the point that is commonly pressed upon in eliciting ovarian tenderness is about two inches internal to the anterior superior spine. That pressure over this area makes pressure on the ovary is very doubtful, for the relationship between the abdominal wall and the ovary is constantly changing by every variation of intraabdominal pressure, and by every change of position of the intraabdominal organs, so that, because of this mobility, it would be impossible to compress the ovary even by pressure on the abdominal wall, applied directly over the ovary. The only effect would be to cause a slight change in its position. Such an area of tenderness is also found in hysterical men. From such data we may conclude that the pain is not due directly to the ovary, but to related conditions such as irritation of the peritoneum from inflammation spreading from other organs, or from stretching due to traction made upon the peritoneum by ligaments and adhesions joining it to abdominal organs.

(3) It tends to become generalized or diffused.

(4) It follows the lines of spinal segmentation and not of peripheral nerves.

(5) It is associated with exaggerated superficial reflexes.

(6) It is closely connected with the neurasthenic state.

Ovarian disorders may cause pain in distant regions, such as headache, which is frequent. It is most common in the frontal region and is worse at the menstrual period.

The diseases of the ovary causing pain are: neuralgia, displacement, inflammation, abscess, and new growths.

Neuralgia of the ovary is possible, but generally, when ovarian pain is present, it is due to structural changes in the ovary, such as occur in congestion and inflammation.

Displacement of the ovary, or prolapsus, generally produces pain which is felt in the ovarian reference areas. When displacement occurs, vaginal examination will show the ovary to be in a false position. If adhesions between the ovary and adjacent organs have formed, the traction upon the adhering organ will cause pain, which, as a rule, is referred to the pain area of the organ adhering.

Hernia of the ovary is generally associated with hernia of other organs, and is not especially painful. The presence of an ovary in a hernial sac may be surmised from the peculiar sickening sensation which is produced when pressure is made upon the sac.

Hyperemia of the Ovary.—Immediately preceding menstruation, all of the female genital organs are engorged with blood; if they are normal, this engorgement produces no disturbance, except a slight physical discomfort; but, should a hypertrophy or a hyperplasia of the connective tissue have taken place, pain results. This pain is present for one or two days preceding menstruation. It is due to the constriction and pressure upon the terminal nerve filaments of the ovarian stroma exerted by the congested tissues. After the blood flow is well established, the pain quickly disappears. The congestion may be so intense that hemorrhage into the ovarian stroma occurs. This is productive of very intense and throbbing pain in the region of the ovary or in the area to which ovarian pain is referred. It is characteristic of this disorder that it progressively becomes worse, and removal of the ovary is the only hope of relief.

In addition to the passive form of hyperemia, pain also may be due to the active variety. One of these forms of hyperemia is due to bacterial invasion. Here an active inflammation has taken place, and the pain which, in passive congestion, was present only preceding menstruation is now more or less continuous, and is markedly increased during the menses. As may happen during any intraperitoneal visceral disease, the inflammation may spread beyond the organ of its origin and infect the adjacent organs, especially the peritoneum. Such a spreading may also occur in the ovarian inflammation. The referred ovarian pain, as well as the mild local tenderness, is now much increased by the symptoms of the peritonitis arising around the ovary. The most prominent of these symptoms is excessive tenderness in the lower iliac region. The patient, who previously may not have been compelled to take to her bed, now gradually avails herself of such an opportunity. She is inclined to lie flat on her back and to draw up the limb on the affected side; or, if both sides are affected, to draw up both limbs. At the same time the lower segment of the rectus muscle on the diseased side becomes quite rigid. Should the inflammation spread further, all her symptoms are aggravated. She now lies slightly inclined to the side involved, with the limbs drawn up. Breathing is restricted and becomes entirely costal. All motion is abolished and the patient is content to stay in bed, quiet and inactive. Such states are the forerunners of an invalidism that may become chronic, and persist, even after the original cause has been removed. When the acute attack subsides, and the lesion assumes a chronic form, the woman, although she can go about and do her work to a moderate degree, is subject to sudden recurring attacks of inflammation; perhaps in the midst of festivities, or at the time of greatest need, she is compelled to take to her bed until the acute attack again subsides. In any case, she is a poor unfortunate creature, whose life, unless she is relieved by surgical measures, becomes an endless series of periods of ease, alternating with those of the most intense distress.

The pathology clearly shows why this lesion is so painful. An ovary, the seat of chronic inflammation, generally is either sclerotic or cystic, and has a thickened tunica. An examination will disclose that nearly all of the normal stroma has been replaced by connective tissue, so that at the time of menstrual or other engorgement there is no room for expansion, and the sensitive terminal nerve filaments are caught between the swollen masses of tissues and are subjected to a severe pressure. This causes pain. The greater the engorgement the more severe the pain. Should the inflammatory engorgement continue, and connective tissue form, the contraction of this tissue on the sensitive terminal nerve filaments produces the pain. As this pressure is continuous, the pain and distress become constant. Jessett (300, p. 1059) thinks that, in cases in which "the capsule of the ovary is found to be thickened and corrugated with fibrous tissue dipping down into the ovarian stroma, and in which a single cyst or multiple cysts are found incorporated, it is the binding down of these by the dense capsule, which is the cause of pain." Herman, however, thinks that sclerocystic disease of the ovary is generally free from pain unless it is associated with peritonitis. Following inflammation, adhesions to other organs may form. These adhesions are a common cause of pain production.[1]

Abscess of the Ovary.—If the pain of an acute inflammation of the ovary does not subside within a reasonable time, an abscess formation should always be considered. When this occurs, the pain becomes greater instead of less, and a gradual but sure increase in the local tenderness is noticed. At the same time, a mass connected with the uterus and slightly movable makes its appearance in the lower iliac region. At once the question is presented: Is this mass the ovary or is it an inflammation of the tube with a local collection of pus? To answer rightly, it is necessary to call into requisition the most acute diagnostic skill. A diagnosis, it is true, may be easy if one is able to connect the inflammatory mass with the uterus, such as is possible if the abscess is tubal, or to the ovary, if the abscess is ovarian.

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[1] Heywood Smith (305, pp 1060 1061) says that ovarian disease is painful in three stages:

(1) "In stage of congestion through tension of the blood vessels.

(2) "Thickening of the stroma.

(3) "Indrawing or contraction of the fibrous stroma.

"In all these conditions, the tension of the blood pressure at the menstrual molimen is the cause of pain."

Some slight aid in diagnosis of the exact location of the abscess is furnished by the different areas of referred pain; but generally it may be stated that only the diagnostic skill of the examiner, combined with a clear and almost instinctive method of deductive reasoning, will enable him to arrive at a correct conclusion. After all, practically it makes very little material difference whether the abscess is of the ovary or of the tube. Inflammation of the ovary, with abscess formation, demands identical treatment with inflammation and abscess formation of the tube. Both produce localized pelvic peritonitis and pus formation, the symptoms of which have been described.

Adhesions of the ovary frequently follow inflammation. When they form, the resulting pain is related to the functional acts of the adhering organ; for instance, micturition causes pain when the bladder is adherent (this is rare) and defecation is painful when the rectum is affected. In all cases, an ovary which is surrounded by adhesions, as a rule, has been so badly diseased that functional acts of its own, such as ovulation or the congestion incidental to sexual connection, will cause pain.

Tuberculosis.—A tuberculous ovary is, as a rule, not very sensitive. A characteristic of it is that it is closely approximated to the uterus and seems glued to it (Reed, Martin).

Enlarged Uterus.—Pressure on the ovary by an enlarged uterus may, in some rare instances, cause pain. In some cases the pressure hinders the return blood flow from the ovary, and the pain is the result of the consequent congestion.

Relationship of Ovaries and Parotids.—Swelling of the ovary, and pain in the ovarian region, are common in parotitis. Likewise, in cases of swelling and inflammation of the ovary, pain and swelling may, in some cases, be present in the parotids. It hardly seems possible that the association of these two organs can be through nerve paths, for they are so widely separated from each other and each derives its nerve supply from unrelated nerves. It seems more than likely that the exciting cause is a ferment, elaborated either by the ovary, or the parotid, the ferment of the one producing activity in the other.

Tumors of the ovary include cysts and new growths, carcinoma, and sarcoma.

Cysts of the Ovary.—Cystic disease of the ovary, unless peritoneal or pressure symptoms have developed, is without pain (Herman, Gallaban). In a study of eight large ovarian cysts Sampson found that the walls of all were insensitive to touch and pain, the insensibility to pain being tested by cutting, pinching and clamping.

However, traction on the pedicles of cysts causes pain, which becomes greater as the traction is increased. The pain is usually felt at or about the pelvic brim, but if the traction is increased it becomes more diffuse, and is then generally felt over the entire side of the abdomen or in the back. In some instances it may be so diffuse that the patient is unable to localize it. Also, if the pain be severe, nausea may occur. Immediate relief of both pain and nausea follows removal of the traction.

Clamping or pinching of the pedicle gives contradictory results. In some cases it seems to cause pain, even when great care is exercised to avoid all traction on the cyst or on any part of the parietal peritoneum. In other cases the pedicle is relatively insensitive to clamping, cutting, and ligating, if these are accomplished without traction. The pain from pulling or twisting of the pedicle seems to originate from the traction on the parietal peritoneum and the retroperitoneal tissues of the side and back. The pain varies according to the force of the traction, and is felt in the back or side. If it is very severe, the patient may be unable to locate it. When the traction is slight, headache, accompanied by indefinite abdominal and pelvic pains, may result.

As stated above, twisting of the pedicle almost invariably causes severe pain. This is in accord with clinical experience. The pain may be localized in the side or in the back, or may be very diffuse, and is frequently accompanied by nausea. There may be many mild attacks of pain, due to slight twisting of the pedicle, which is quickly relieved by a shifting of the position of the cyst with a consequent relief of pain. A sign very characteristic of twist of the pedicle is that the pain is very much increased when the patient turns from one side to the other. This is due to the rolling over and dragging on the twisted pedicle, by the tumor (Donald and Hickley). Should the twist persist, strangulation may result, and another source of pain may arise in the escape of the fluid from the engorged cyst. However, pain will not immediately be felt unless the contents of the cyst are such that they irritate the parietal peritoneum, though they may be such that a non-infectious irritative peritonitis may ensue, and pain may arise from this source.

Pain may also be associated with acute swelling and sudden enlargement of the cyst, such as occur at the time of great pelvic engorgement, as, for instance, during menstruation or at the time of sexual connection. In some cases the sac ruptures, and blood is thrown into the peritoneal cavity. Symptomatically, it now closely resembles ruptured extrauterine pregnancy, from which it is hard to diagnose (Winter, Sampson).

Adhesions between the cyst and other structures will not cause pain unless the adhesions unite the cyst to sensitive structures (parietal peritoneum), and conditions arise which cause traction on the same.

The presence of abdominal or pelvic pain in patients with ovarian cysts usually indicates either secondary changes in the cysts, involving some sensitive nearby structure, or the presence of some other condition, independent of the cyst, which may cause pain. Previous symptoms may aid in the diagnosis.

Therefore, the principal causes of pain arising from ovarian cysts are traction or twisting of the pedicles and the traction on the parietal peritoneum by adhesions (Sampson).

New growths of the ovary as a rule are not painful. Out of an enormous experience Mr. Doran could only find sixteen which were painful and of those two were due to adhesions. New growths are divided into two classes: (1) benign and (2) malignant. The benign growths are painful when they interfere with the ovarian functions or when they reach such a size that they stretch the anterior abdominal wall (Donald and Lickley, p. 430). Likewise, in the earlier stages, from the same cause, the malignant growths are painful; while in the later stages pain is also caused by infiltration of the nerve fibers by the tumor cells, or by the action of the toxins of the malignant process upon the incorporated terminal sensory filaments. In some cases torsion of the pedicle of the ovarian tumor occurs and pain is severe. It is due both to congestion and enlargement of the ovary from the obstruction to the blood flow, and to the injury to the nerves in the pedicle. In every case it must not be forgotten that malignant growths may be present and not cause the least pain (Brothers).

THE VAGINA

Nerve Supply.—Pain is a common indication of vaginal disorders; yet, because of the easily accessible location of the vagina, other and better methods of diagnosis than pain syndromes are available. The vagina is supplied by sympathetic and cerebrospinal nerves. The sympathetic fibers are derived from the inferior hypogastric, while the cerebrospinal are derived from the third and fourth sacral nerves. The reference pain seems to be in the fourth sacral area. The sympathetic fibers are supplied to the upper end of the vagina, which is comparatively insensitive, while the lower portion, which is quite sensitive to irritation of every description, is supplied by the cerebrospinal, through the pudic, which is derived from the third and fourth sacral.

Affections Causing Pain.—Pain produced by palpation of the vagina should always lead to inspection, as it may be due to colporitis. This is indicated by the reddened and inflamed appearance of the mucous membrane. A profuse discharge is also present. In inflammation the pain is of a burning type. Tenderness of the vaginal wall and the pelvic floor is marked.

Hemorrhage into the soft parts surrounding the vagina is, as a rule, painful. Even during the pains of labor, as Reed says, the patient's attention is immediately attracted, when this complication occurs, by the increased pains which are then produced. On the contrary, chronic edema or hemorrhagic infiltration of the vagina or vulva is entirely free of pain.

A *small nodule on the vagina* may be a neuroma or a polypoid growth of the urinary meatus. Both are very painful. *Tuberculous disease of the vulva* is at first not painful, but later it may cause considerable pain. *Cancer of the vulva* is nearly always very painful. Fortunately, the disease is very rare. *Cysts of the vulva*, unless inflamed, cause no pain. *Cancer of the vagina* is generally free from pain until late in the disease.

Pain on urination and on coitus generally means an inflammation of the lower genital tract or a cystitis. This inflammation is frequently gonorrheal, but may be the result of trauma. Every case of pain in the lower genital tract, associated with a copious discharge, should be examined for gonorrhea. If the affection is gonorrheal, as a rule, the vulvovaginal gland (Bartholin's) is involved. The onset of this complication is indicated by sudden acute pain localized to the region of the gland. Examination discloses the enlarged and inflamed gland.

A marked pain on urination may indicate a vaginal (anterior wall) tuberculosis. A slight fissure at the urethrovaginal juncture is also a cause of severe pain.

Sexual Connection.— When pain is present during sexual connection, the female is the one who most frequently complains, except possibly in some cases of disproportion of the parts, when both the male and the female are pained, though the female suffers much more than does the male. Especially is this so in the period following the first intercourse. To the female, the first intercourse is almost invariably painful, and at this time the male should exercise the greatest moderation. After a short time, this pain during intercourse wears away, unless the partners are ill-

DIFFERENTIAL DIAGNOSIS—DYSMENORRHEA

SYMPTOM	IMPERFECT DEVELOPMENT OF UTERUS	MECHANICAL	ENDOMETRITIC	HYPERÆSTHESIA UTERUS
History.	Pain often begins with menstruation, but may come on after years of normal menses—patients are often otherwise under-developed.	Generally dates from the first menses—patients are strong and healthy.	History of previous disease of the uterus, either following childbirth or as a result of gonorrhea.	Patients are extremely neurasthenic and nervous; generally occurs in those who work very hard or who are subject to many worries.
Pain.	Very severe.	Only present during menstrual period.	Pain severe.	Very severe.
Time of onset.	Several days previous to flow.	Only a few hours before menstruation begins.	Previous to menstruation—often ceases as soon as the flow becomes profuse—but may continue throughout the entire period as long as the membranes are being cast off.	With menses.
Time of cessation.	When flow becomes pronounced.	As flow becomes profuse.	A day or two after menstruation has commenced.	With the stopping of the menses though a feeling of discomfort may persist for some time.
Discharge of blood.	Very slight—the pain varies inversely as the flow.	In stenosis of cervix, very slight.	Frequently clots and often pieces of membrane.	Generally normal.
Course and termination.	Runs a chronic course. It frequently becomes cured when pregnancy occurs.	Chronic—nearly always relieved by pregnancy.	Essentially chronic.	Essentially chronic. It improves on improvement in the patient's general condition.
Referred pain.	Uterine areas.	Uterine areas.	Uterine areas.	Uterine areas.
Examination.	Shows small undeveloped uterus.	Shows abnormal position of the uterus or a stenosis of the cervix.	On sounding, sensitive areas can sometimes be found in the corpus uteri.	Normal uterus. Abnormal nervous system.

mated; then the aversion of the female to the male may hinder the development of the normal libido so that the vagina instead of being moist and well lubricated during intercourse will be dry and rough. Under these circumstances the friction which ordinarily is productive of so much pleasure, inversely is productive of as much distress. This is only a temporary impediment, however, and, under propitious circumstances, entirely disappears. It is only when it persists longer than a reasonable length of time, for instance, a few months after the first intercourse, that it should become a subject of medical inquiry.

How much the future happiness of the husband and wife may depend on the cure of this abnormality can be judged when it is borne in mind that no true conjugal bliss can be experienced so long as natural and pleasurable intercourse is denied. Many men spoil their entire married life by reason of stupidity and lack of ordinary common sense in the act of coitus. No two women are entirely alike and each should be treated differently and be made the subject of careful medical study if difficulties due to painful intercourse arise during married life. In the majority of cases the female patient generally is the first to complain and to seek medical advice, because, as a rule, she is the one who suffers most: She should be closely questioned as to the time of the pain, as to whether it occurs before, during, or after intercourse, and she should also be asked to define the positions in which intercourse is most painful.

Pain at the beginning of intercourse generally indicates a lack of lubrication of the vaginal canal, and this, since it is functional, is generally due to an absence of sexual desire on the part of the female, or a fear of the results of a coitus even though the desire be present. These women are the ones who are unable to experience more than a single coitus a night without suffering greatly for it. They generally complain of a burning pain during the early stages of the act, which disappears under the excitement of the libido to reappear in many cases after the conclusion of the act. Generally, the pain disappears almost entirely in a very short time, but often may persist to such a degree that the female will not again, for some time, permit the approach of the male. Should pain occur during the act, it indicates some abnormality or pathological condition of the female parts; inflammation or ulceration of vaginal mucosa. Inspection will reveal this. It also may indicate pus tubes, oöphoritis, or appendicitis. In these cases pain is present during the whole of the act and remains for some time after. It is also present on particularly forcible and violent movements, which the woman is very averse to making. When pain occurs at the end of the act, after the orgasm has taken place, it indicates some trouble with the uterine glands. Such a period of pain is very unusual. Perimetric adhesions also cause pain, which is more marked toward the end of the act.

In some women, by whom pain is complained of in the vagina during the sexual act, digital examination reveals only a painful spot at some point in the vagina. No pathological lesion can be found.

The pain of the male arising during sexual intercourse is slightly different in its manner of production from that of the female. The periods of pain likewise may be divided into: (1) the pain prior to connection; (2) the pain during connection, and (3) the pain following connection.

Pain before connection is due to some pathological lesion inhibiting erection of the penis, the most common being inflammation of the urethra (frequently gonorrheal).

Pain during connection is due to herpes of the glands, ulceration of the glans penis, fissure at the meatus, inflammation of the glans or foreskin, adherent prepuce, or an inflamed frenum.

Pain at the time of the orgasm and persisting for some time afterward is due to prostatitis or posterior urethritis. In any case, when pain during intercourse is complained of, all possible lesions in both the male and the female should be thoroughly investigated before forming a decision.

CHAPTER XXXIII

PAIN IN THE CHEST

When a patient has a pain in the chest, the idea first suggested to himself, as well as to most physicians, is that he is suffering from some lesion of the heart or of the lungs—of the heart, if the pain is in the left half of the thorax; of the lungs, should the pain be in any other part of the chest. While in many cases this is true, in many others it is not; and, unfortunately for the careless physician, the exceptions far outnumber the rule. Pains in the chest are the result of many causes.

In the first place, they may be due to injuries or disease located in any one of the structures composing the chest walls; or they may be felt in the walls and be produced elsewhere, as is seen in referred, reflected, and transferred pains.

THE THORACIC WALLS

The structures composing the thoracic wall are: (1) the skin, (2) muscle, fascia, and nerves, (3) bone, and (4) pleura and subpleural tissues.

THE SKIN

The skin of the thorax is painful in all those lesions which cause epidermic pain, such as neuralgia, hysteria, inflammation, hyperesthesia and hyperalgesia from reflex causes.

Neuralgia.— Neuralgia produces a very tender skin, so that the slightest touch is painful. It is a frequent accompaniment of influenza or some of the acute infectious diseases. When found, inquiries should be made in regard to the presence of any recent illness. A characteristic of neuralgic pain is that it moves around freely from place to place, and does not stay very long in any one location. It is also present in other parts of the body, and the subjacent muscular tissues are, as a rule, very sensitive to pinching or squeezing.

Hysteria.—In hysteria the skin is tender only in certain areas.

These areas in the same person are constant in location, and generally are produced only by certain types of irritants. In some these areas may be sensitive to pinching and entirely insensitive to pin-point pressure; while in others these sense perceptions may be reversed.

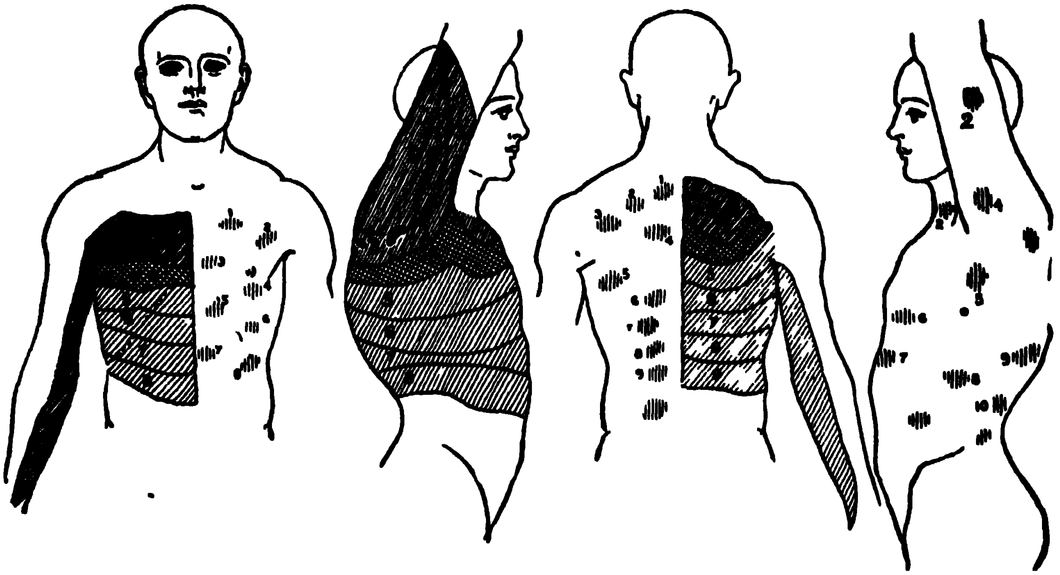

FIG. 173.—AREAS OF CUTANEOUS DISTRIBUTION OF THE THORACIC SEGMENTS. (Head, Brain, Vol XVI, p 130)
The 1st, 2d and 3d thoracic areas are the ones mostly affected in cardiac disease. The 4th thoracic is the one especially involved in lung disease.

Inflammation.—Inflammation of the skin of the thorax is uncommon, except when local irritation, particularly in the form of a mustard plaster, etc., has been applied.

Hyperesthesia and Hyperalgesia.—Hyperesthesia and hyperalgesia are the result of nerve irritation, either in adjacent or in distant areas. The adjacent causes may be inflammation of any of the sublying organs, such as osteomyelitis of the ribs, myositis of the chest muscles, or a communicated inflammation from the pleura. In all cases where pain is complained of in the chest these conditions should be carefully sought. Symptoms leading to the diagnosis of inflammation are swelling, local edema and restriction of the respiratory movement on the affected side. In addition to local causes, hyperalgesia may also be produced reflexly by lesions of the heart and lungs. The segmental areas of these hyperalgesic zones are given, according to Head, in Fig. 178.

MUSCLE, FASCIA AND NERVES

Muscle Pain.—If there are no definite zone areas of hyperalgesia and hyperesthesia and the areas of sensitiveness correspond fairly well to the limitations of the different chest muscles, myositis is very likely present. When it is, pain is produced by grasping the muscle between the fingers and pinching it, or else by trying to raise it from its bed. If the muscle is hypersensitive, pain results. Also, pain is produced on breathing by movement of the affected muscle, while rest gives relief. If the intercostal muscles are affected, sudden pressure in the intercostal spaces causes pain, and breathing is inhibited on the affected side. If myositis be present light pressure applied to the muscle is grateful, and severe pressure is painful. Also the pain does not radiate. In neuralgia, on the contrary, pressure of all kinds is most painful and radiation is usual.

Fascial Pain.—Musser speaks of a chronic inflammation of the fibrous attachments of the muscles as being one of the causes of chest pain. This pain is increased by motion, and persists for long periods.

NERVE AND MUSCLE PAIN

Nerve Pain.—If pain is present in the intercostal spaces, either the nerve or the muscle is involved. The nerve may be affected either with neuritis or neuralgia.

Neuritis.—When the pain is due to neuritis, it is referred along the interspaces and the breathing is very much restricted. The pain is also produced by pressure made in the interspace about two inches from the vertebra, and when so produced runs out anteriorly over the distribution area of the intercostal nerves. A good way to determine the presence of nerve inflammation is to run the finger round from the back to the front, in the intercostal space, making, at the same time, considerable pressure. If neuritis is present, the pain is severe.

A somewhat similar condition is the nerve pain due to herpes zoster. In this pain is very severe over an intercostal nerve. Tenderness, also, is excessive. In a day or two small vesicles make their appearance over the site of the pain. Herpes then becomes apparent.

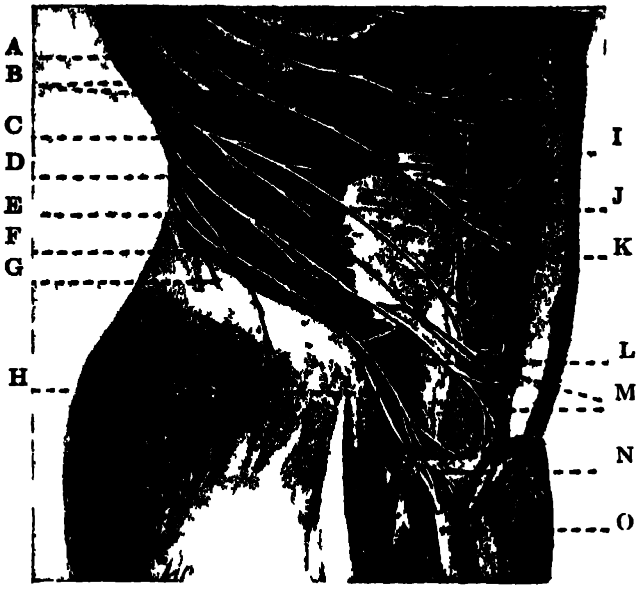

Fig 174 —Points At Which The Intercostal Nerves Become Superficial. Especially the 11th and 12th over the iliac region, which is the location of the referred pain in pneumonia and diaphragmatic pleurisy of the right side (Splateholz, Leipzig, 1909, vol 3, 740)

A, XII rib

B, Intercostal nerves IX-X

C, Intercostal nerve XII

D, M transv abdom

E, Iliohypogastric nerve

F, Lateral branch intercostal nerve XII

G, Ramus cutaneous lateral iliohypogastric nerve

H, Ilio-inguinalis nerve

I Sheath rect abdom

J Umbilicus

K M rect. abdom

L M obliqu int abdom

M Rami cutanei ant intercostal nerve XII

N Annulus inguinalis

O Funiculus spermaticus

Neuralgia.—True intercostal neuralgia, like all neuralgias, may arise without any obvious cause. The fifth to the ninth thoracic nerves are the ones generally involved. The pain, owing to the anatomical relation of the parts, is worse on breathing, or on any movement of the chest wherein stretching of the nerve (pressure irritation) may occur. This pain must not be mistaken for pleurisy. The absence of the pleural friction rub is evidence of value against its pleural origin. The reason for this confusion is clear when it is stated that the thoracic nerves divide into two branches, the external and the internal. The internal supply the pleura, and the external supply the anterior body wall, so that, should the pleural branches be affected, the stimulus may be transferred to the external branch and neuralgic-pleural pain may result. On the other hand, when the first two dorsal nerves are affected, the pain may run down the inner side of the arm through the intercostal-humeral nerve. Intercostal neuralgia may arise from thickening of the spinal meninges, specific or tuberculous meningitis, or from new growths, osseous or otherwise. It may also arise from intravertebral pressure, diabetes, or other general conditions causing neuralgia. An intercostal neuralgia may be the early sign of a tabes or of a spinal cord tumor.

BONE PAIN

Bone Disease.—Bone diseases (osteomyelitis) produce pain, soreness, and redness over the area under which lies the necrosing bone tissue. In these cases the location of the swelling and the signs of inflammation render a diagnosis easy. Elevation of temperature and an increase in the pulse rate also aid in the diagnosis.

Fractures.—Where a rib is fractured, the pain, on breathing, is very severe. Generally, the inspiratory act commences all right, but, because of pain, is brought to a sudden stop. On palpation, crepitus and abnormal mobility of the rib can be felt. A diagnostic sign of value is pain over the location of the fracture when pressure is made between two hands, one placed on the anterior chest wall and the other on the back.

PLEURAL PAIN

See p. 769.

REFERRED AND REFLECTED PAINS OF THE THORACIC WALLS

Referred and reflected hyperalgesia have been mentioned as causes of chest pain. These are generally accompanied by subjective pain. There may also be a subjective pain without hyperalgesia. This pain is referred from distant lesions, such, for instance, as pain in the shoulder, in diseases of the gall bladder, or posterior thoracic pain in lesions of the stomach. Both of these are transferred pains, the same as the pain which is present in the chest wall over the cardiac area in some cases of heart disease. All these pains depend for their production upon the transference of stimuli from the sympathetic, through the cells in the cord, to the nerves supplying the body wall. In some cases, this reflection passes entirely across the cord, and the pain is felt on the side opposite to that of the lesion. It also may be transferred to a higher or lower level of the cord and be felt at a higher or lower level of the body.

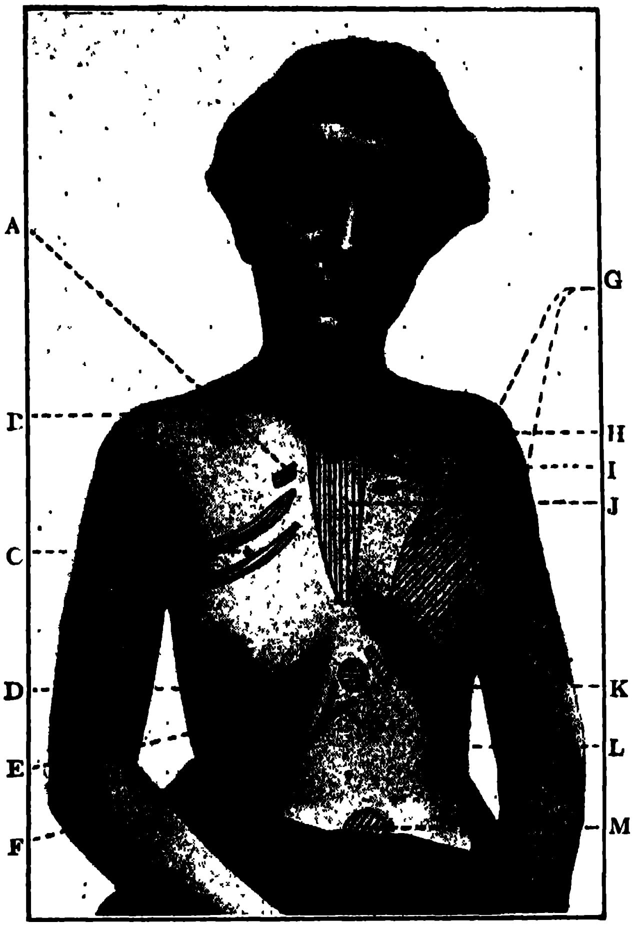
A, Tenderness in aortitis
B, Liver disease
Gall-bladder disease
Extra-uterine pregnancy ruptured
C, Pain in intercostal spaces:
1, Intercostal neuralgia
2, Referred pain (spinal caries)
3, Intercostal myalgia
D, Tenderness due to traction from coughing
E, Gall-bladder disease
F, Tenderness in liver disease
A
B
C
D
E
F
G
H
I
J
K
L
M
G, Cardiac disorders
H, Subacromial bursal inflammation
I, Tenderness in angina pectoris
J, Bronchitis
Necrosis of the sternum
Mediastinitis or mediastinal sarcoma
Aneurysm
Hyperchlorhydria
K, Gastric ulcer
L, Disease of the spleen
M, Disease of the cecum

FIG. 175.—LOCATION OF TENDERNESS IN VARIOUS DISEASES OF THE CHEST AND ABDOMEN.

These transferred pains, when present in the chest, often cause mistakes in diagnosis, since they are likely to cause confusion as to which is the side of the lesion. They may also attract attention from a distant causative pathology, as is sometimes seen in appendicitis, when pneumonia or pleurisy is diagnosed with an entire disregard of the appendiceal condition. However, the diagnosis is not always wrong, for in some cases there may be local conditions (congestion, etc.) in the lungs to account for the chest pain associated with appendicitis, as is emphasized by J. B. Roberts (576). In other cases the pain may be felt in the appendix area when the lesion is in the lung. This pain may be due to irritation from a diaphragmatic pleurisy associated with the pneumonia, the stimulus being carried through the eleventh and twelfth intercostal nerves. The pain, as is usual, would then be felt at the point where the eleventh and twelfth nerves become superficial, that is, in the right lower quadrant of the abdomen.

Transferred and reflected pains, in distention of the stomach and colon, are found on the lateral surface of the chest, following the points of attachment of the diaphragm. These pains occur in the two conditions in which the greatest traction on the diaphragm is present, namely:

(1) In states of great cardiac and respiratory activity. The heart and lungs, which in a normal person, under abnormal conditions of exertion, would be incited to great effort, would, in a patient who is emphysematous, be incited to much greater effort, owing to the difficult circulation of blood through the lungs. This relatively greater increase of cardiac and respiratory activity would produce much greater than normal traction on the diaphragm, and this, in turn, would be communicated to the chest wall at the points of diaphragmatic attachment. Thus it is that after violent exercise pain is so frequently produced at these points of attachment.

(2) In enlargement and dilatation of the stomach it is also common to find pain or a sense of traction along the line of attachment of the diaphragm to the chest wall. This pain is the result of the diaphragmatic pull.

Distention of the stomach and intestine frequently causes such a sudden and severe pain in the cardiac region that it is confused with angina pectoris; but a hurried examination of the epigastrium will disclose the enlarged and tympanic stomach and quickly clarify the diagnosis. The distended large intestine, also, at times produces the same symptoms. Symptomatic of the latter condition is a painful spot on the left side of the chest at the margin of the ribs (in men at a point opposite the suspender button). In women the presence of this pain frequently causes them to loosen the corsets (Reynier, 231).

According to Brown (Osler's "System"), pain over the front of the chest is, as a rule, a referred pain from a diseased lung, though it may also be due to an acute pleurisy or to the traction of pleural adhesions. According to the same author, pain over the lower part of the thorax may be due to pleurisy, while, if it is over the interscapular region it is, as a rule, referred, and is the result either of a pleurisy or of pressure on the intercostal nerves from enlarged mediastinal glands.

Pain radiating around the chest wall is also present in herpes zoster and tabes dorsalis, as well as in vertebral caries, if the intercostal nerves are involved. Mediastinal glandular involvement at times produces a pain in front of the chest, beneath the sternum, and at other times in the back, underneath the vertebræ. Should pain be present in the back between the scapulæ, the following should be sought: vertebral disease, lung disease, particularly tuberculosis (here the pain is more of an aching), aortic disease (aneurysm), pleural disease (pleuritic adhesions), splenic and gastric lesions (inflammation and over-distention). Should pain be present at the angle of the scapula on the right side, it indicates liver involvement; if at the angle of the scapula on the left side, it indicates splenic involvement.

Localization of Pain on the Chest Wall.—Pain on the lateral wall of the thorax may be due to pleurisy, intercostal neuralgia, or pleurodynia. Upon the upper surface of the thorax, in the region of the shoulder, pain may be due to pericarditis (left shoulder) (McKenzie), peritonitis, pleurisy, hepatic abscess (right shoulder), or colic. According to Monro (32), Schmidt, and others, the pain referred to this area is propagated through the phrenic nerve to the fourth cervical (sometimes, also, to the fourth and fifth), and thence through the external supraclavicular

CHEST PAINS AND DIAGNOSTIC POINTS

Symptoms	Pleurodynia	Intercostal Neuralgia	Fractured Rib	Pleurisy	Pneumonia
Pain.	1. On breathing. 2. On movements of chest. 3. Generally present in other muscular or fibrous structures. 4. Often associated with increased acidity of urine.	1. On breathing. 2. Generally runs around from vertebra to about the anterior axillary line. 3. May be present in other structures. 4. No change in the urine.	1. On breathing, is localized to one particular spot, generally is of a stabbing character, and is very short and sharp, inspiration being suddenly restricted. 2. Localized to place of fracture.	1. Occurs during breathing, and may be present during both inspiration and expiration, though if the pleurisy involves the accessory pleural spaces, the pain is only felt during the latter stages of inspiration. 2. May be over the whole extent of the chest.	1. There is no pain except when the pleura is involved.
Tenderness.	Present.	Pressure generally relieves it. So also on local pressure over the intercostal nerves which run along the intercostal spaces near to the upper margins of the ribs increases.	Very tender at point of fracture.	1. Tenderness may not be present.	1. Tenderness may not be present.
Associated Signs.	Muscles are sensitive.	Tenderness is present at the points where the terminal filaments come to the surface. Anemia generally present. Neuralgia is often present in other locations.	1. Crepitus. 2. Small enlargement at place of fracture sometimes is apparent.	1. Pain on coughing. 2. Sputum light, colorless, and frothy. 3. Friction fremitus. 4. General elevation of temperature and increase of pulse. 5. Cough, short and hacking.	1. Râles crepitant. 2. Elevation of temperature, pulse and respiration increased. 3 Sputum, rusty colored. 4. Consolidation, dulness on percussion. 5. Vocal resonance increased. 6. Cough.
History.	Of lithemia or myalgia. Exposure to cold.	Of catching cold.	Of an injury.	May be no definite history.	As a rule, of exposure to cold and dampness.

nerve (derived from the third and fourth cervical nerves) to the integument over the shoulder tip.

Pains above the shoulder are due to involvement of the supra-acromial nerves, branches of the fourth cervical. Deep-seated pains, referred to the parts over the shoulder joint, and in the deltoid, lie in the distribution area of the circumflex nerve, which originates from the fourth, fifth, and sixth cervical nerves. When the pains are behind the shoulder and over the deltoid, they are also due to involvement of the circumflex, and at the point where the nerve becomes superficial a painful spot is present (Dana, 123b). Tenderness is present over the eleventh and twelfth dorsal and the first and second lumbar vertebral spines in gastric lesions. (For other points of tenderness in gastric lesions, see under Stomach.)

PAINS WITHIN THE THORAX

Inside the thorax are the following, all of which have the power, directly or indirectly, of causing pain: (1) the pleura, (2) the heart, (3) the lungs, (4) the mediastinal glands, (5) the esophagus, and (6) the nerves and vessels passing through the thorax.

In diseases of the heart and lungs hyperalgesia may be present in the area of the first six dorsal visceral segments. Sometimes it is felt as high as the seventh or eighth cervical or as low as the seventh or eighth dorsal (Head). Generally, though, in the case of the heart, the hyperalgesia is limited to the upper four dorsal, while that of the lungs is comprised within the upper six dorsal. The areas of distribution of these segments are illustrated in Fig. 173.

THE PLEURA

Innervation.—The parietal pleura is innervated by the intercostal, sympathetic, and vagus nerves. The visceral pleura is innervated by the vagus and sympathetic. The pericardial pleura sends its sensory stimuli through the vagus and possibly through the phrenic. The diaphragmatic pleura sends impulses over the phrenic and also in part through the last six intercostal nerves.

In pleurisy pain is a symptom of great diagnostic value, because it is almost invariably present.[1] The method of its production and its areas of distribution have been discussed in the preceding pages. In some cases the cutaneous hyperalgesia may be on the opposite side of the body to the one affected; but the deep tenderness is always on the affected side, and this is a point to be remembered, for it may be most useful in a differential diagnosis. Percussion is a good method of defining this deep tenderness. On palpating or percussing those cases of pleurisy in which pain is complained of over the abdomen as far as the umbilicus, it is noticed that tenderness is not present on percussion and palpation beyond the costal margins, and this is a sign of the utmost value in the making of a diagnosis. When tenderness to deep pressure or percussion is present, it is a fair indication that the diseased process lies in the percussed area.

The mere fact that an area painful to palpation or percussion is present does not necessarily prove a pleural involvement, for these pain areas may be due to other causes than a pleurisy; likewise their absence is of no negative value, for a pleurisy may be present and run a painless course. A method of arriving at a diagnostic conclusion as to whether the pain felt in the chest wall is or is not due to pleural involvement is to inhibit the respirations on the affected side, as by strapping. This will at once stop the pain, if it be due to a pleurisy. On the right side, if the pain is the result of perihepatitis, strapping will aggravate it. In diaphragmatic pleurisy respiration is painful, but not nearly so much so as it is in pleurisy of the lateral wall. In many cases of diaphragmatic pleurisy the pain is referred to the chest and abdominal wall, in the distribution area of the tenth, eleventh, and twelfth thoracic nerves.

The pleura also is probably connected with the seventh, eighth,

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[1] According to Dr. Lord, 89.70 per cent. of all cases of serofibrinous pleurisy give rise to pain at least sometime in their course.

and ninth visceral dorsal segments, so that the pain, when reflected, is felt in these segmental zones, most commonly on the right side (Head. See Fig. 173). This corresponds closely with the statements of Huss (102), who says that, in pleuritis, irrespective of the area in which the disease is present, the pain occurs principally in the region of the mammillary line, between the fifth and eighth ribs. When the inflammation lies in the outer and lower half of the pleura, the pain may be felt in the region of the hypochondrium, in the region of the quadratus lumborum, and in the epigastrium (though infrequent).

In all cases in which the parietal pleura is involved (and it is involved in nearly all pleuritic processes of whatever origin) pain due to irritation of the intercostal nerves is also felt, and is localized to the diseased area. If the pleurisy should extend and involve the mediastinum there is then produced a mediastino-pericardio-pleuritis. This causes severe pain on breathing. Percussion over the sternum is painful, and pressure in the intercostal spaces on either side of the sternum causes pain. Reflected and referred pains are absent; only the direct pain is present.

Character of the Pain in Pleurisy.—The pain of pleurisy may be slight or severe, depending upon the type and the location of the pleuritic involvement. If the visceral pleura is involved, it is not as severe as though the parietal pleura were affected. Likewise involvement of the diaphragmatic pleura, in the absence of deep inspiration, may produce no very severe pain. In all cases pleural pain of whatever origin is generally provoked on deep inspiration, coughing, yawning, singing, and laughing. As a rule it is localized in the areas of maximum tenderness of the seventh and eighth dorsal segments (q. v.). If the intercostal nerves become affected and intercostal neuritis results, the pain is referred to the anterior area of distribution of these nerves. Should the pain suddenly cease, it is frequently an indication of a beginning hydrothorax.

In those cases in which the subjective pain is on the opposite side to the one involved Gerhart thought that the transference might be due to a communication in the anterior mediastinum, between the two sets of intercostal nerves. In this regard, Huss speaks (102, p. 245) of a case in which such a connection was found between the fourth and the middle part of the third nerve on the right side and the corresponding nerve on the left side.

CHAPTER XXXIV

HEART DISEASE

GENERAL CONSIDERATIONS

It has frequently been said that cardiac disease does not cause pain. Even well-known clinicians have claimed that the heart (of itself) does not give rise to painful sensations. They attribute all the pains which may be present in the chest, over the area of the heart, as not being due to disease of the heart itself, but as the result of other changes, such as rheumatism of the pectoral or intercostal muscles, or intercostal neuralgia. Yet it is not always wise for the clinician summarily to dismiss a pain in the chest and rate it as being due to any one of these conditions, especially so in those who are weak and debilitated from overwork or disease. In the former class of patients the pain, though slight, may be the first indication of a cardiac exhaustion. Early and efficient remedies directed against this exhaustion may prolong the patient's life for years, while neglect of the warning signs may pave the way for his early death. Every case of pain or discomfort, in the areas usually associated with cardiac disease, should lead the physician to question closely his patient as to age, habits, manner of work, and past diseases, and then to make a thorough examination of the entire body, with special attention to the chest. The physician should also bear in mind that the heart may be greatly diseased and yet give no apparent sign of its distress, excepting in cases of referred visceral hyperalgesias. Should these hyperalgesias be present, they of themselves, even though no other signs of heart disease are apparent, are of sufficient value to merit a diagnosis of cardiac involvement. The absence of hyperalgesic zones does not carry weight against, as their presence carries weight for, the existence of cardiac disease.

It was in 1873 that Loomis first called attention to the association of heart lesions with referred pains. For instance, in an article published in that year, he says that "disturbances of the cardiac plexus, by reflex irritation, produce pain in the arm, in the top of the shoulder, and the base of the neck." However, it was not until Head and McKenzie published their articles on referred and reflected pain that a clear conception of this relationship of the pain to the cardiac disease was reached.

Nerve Supply of the Heart.—The cutaneous hyperalgesia, in a case of heart disease, lies in the cutaneous tissues which extend from the eighth cervical to the fourth dorsal segments, as illustrated in Fig. 176. In this illustration, it should be noticed that the eighth cervical and the first and second dorsal zones are shown as extending down the arm. This downward extension explains why, in some cases, the pain of cardiac disease runs down the inner side of the arm, frequently as far as the little finger. The reason for this downward extension is that, in early embryonic life, the spinal nerves are distributed around the entire body; but as the body develops, and the arms and limbs are projected from its surface, the nerves are dragged out with them, and are carried by developing tissues farther and farther away from their point of origin, until we find them in irregular though always concentrically arranged zones, as in man. Ross explains how, in some cases, the areas supplied by the dorsal segments are not continuous from the chest to the arms, but are broken by intervening areas; for instance, the third dorsal is broken, the gap between the two portions being made by the ingrowing second dorsal. The different segments of skin grow with various degrees of rapidity, so that in some cases the different skin segments become separated from each other.

Diagnosis by Means of Location of Referred Pain.—The manner of distribution of the cord zones explains how the pain of cardiac diseases may be distributed down the inner side of the arm, and at the same time over the left upper half of the chest. It also explains why, in some cases of cardiac lesions, the breasts are very sensitive. Hyperalgesia due to cardiac disease may first appear only after some severe and debilitating disease, such as pneumonia, which so sensitizes the already reduced tissues that the slightest stimulus will give rise to pain (in the cardiac areas). At the same time the hyperalgesic areas of the debilitating disease will be present. For example, if the heart is affected (without pain) and the patient catches pneumonia, then the previously non-painful heart becomes very painful, and cutaneous areas of hyperalgesia appear. These heart areas may persist for a long time after the pneumonic areas have disappeared, and vice versa. In cardiac disease certain muscles, such as the pectorales, the intercostals, the trapezius, and the sternomastoid, may be very sensitive to pinching and squeezing.

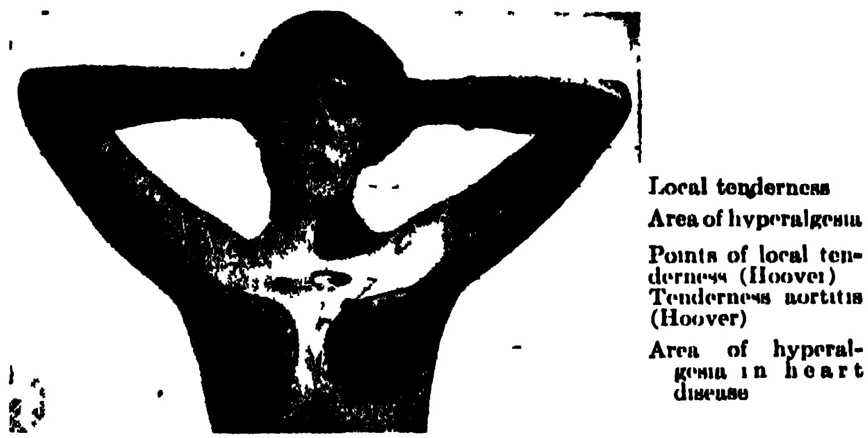

Local tenderness
Area of hyperalgesia
Points of local tenderness (Hoover)
Tenderness aortitis (Hoover)
Area of hyperalgesia in heart disease

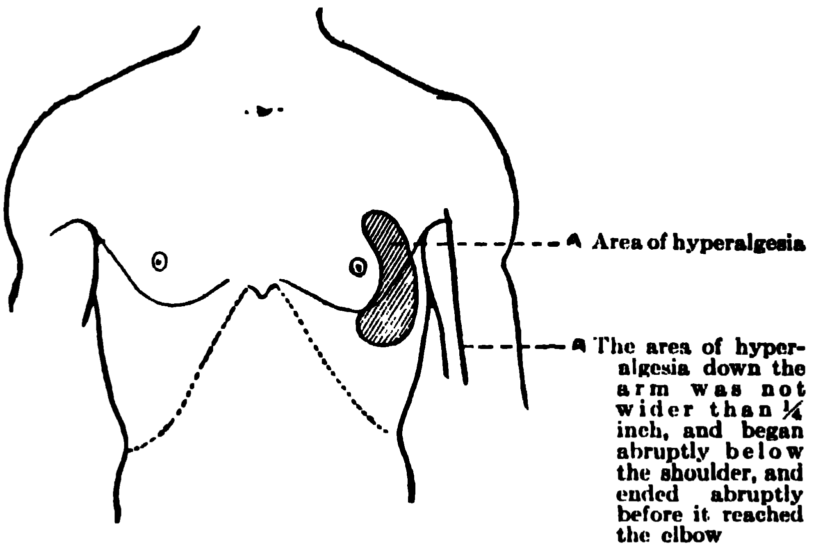
FIG. 176.—LOCATION OF HYPERALGESIC ZONES AND THE AREAS OF PAIN IN CARDIAC AND AORTIC LESIONS.
In some cases there is a crossed reference and the pain is referred to an analogous area on the opposite (right) side.

That the pain felt in heart disease is not local but referred pain is set forth in the following arguments:

(1) The heart is in contact with the chest wall in only a small part of its anterior surface, and the pain and tenderness associated with the cardiac disease cover an area several times this extent.

(2) If the pain were present in the heart itself, movements of the heart, such as expansion or contraction, would produce a variation in the pain and tenderness. Such is not the case. The same arguments apply to the origin of pain in lesions of the lungs.

Another point of interest, as well as of value, in diagnosis of heart lesions is that in the first attack of an inflammatory affection of the heart, say, in endocarditis, the hyperalgesic zones are very prominent, increasing and receding with each exacerbation or recession of the disease. After the first attack, when the process becomes chronic, as in chronic valvular disease, the referred zones of hyperalgesia are, as a rule, absent. However, if at this time an acute attack of endocarditis should ensue, the hyperalgesic areas may or may not appear. The reason that they do not reappear is not clear, but it probably is the result of the destruction, in the first attack, of the sensory terminal nerve filaments in the endocardium, so that, during the second and subsequent attacks, they cannot respond to the irritating stimuli. This is well illustrated in the case of Lillian H., a school girl affected with chorea. While under observation a mitral regurgitation developed, and at its height gave rise to the hyperalgesic areas shown in Fig. 177.



Area of hyperalgesia

The area of hyperalgesia down the arm was not wider than ¼ inch, and began abruptly below the shoulder, and ended abruptly before it reached the elbow

Fig. 177.—An Area of Hyperalgesia Corresponding to Portions of the 2d, 3d and 4th Dorsal Zones.

The 2d dorsal is almost absent. The area corresponding to a portion of the 4th dorsal is more than ordinarily prominent. In this case also there was no tenderness to blunt pressure, even in the area which was hyperalgesic to pin-point pressure. The case was a mitral regurgitation recovering from an acute attack.

As improvement occurred the zones gradually became less extensive, first disappearing in the arm, then over the chest, until only a small area over the heart remained (See Fig. 177). This was the area of the third dorsal segment (the segment most frequently associated with lesions of the left auriculo-ventricular opening). In cases of mitral disease I have found it present even when the other segmental areas were absent. Another fact worthy of attention is that disease of the aorta seems to be associated especially with the first dorsal segment. In all cases it will be observed that the segmental areas are not as clearly defined as they are in the figures in which the distribution areas of the visceral segments are shown. (See Figs. 24 to 26.) This is probably due to the fact that hyperalgesia in cardiac disease is felt best in the center of the area which is most frequently associated with the heart; and that the intensity of the sensation gradually fades into the adjacent areas. In many cases the cardiac hyperalgesia does not exactly coincide with the area of the cord zones, but may overlap them or be confined only to certain portions of the zones, which are most likely the zones of maximum tenderness of Head.

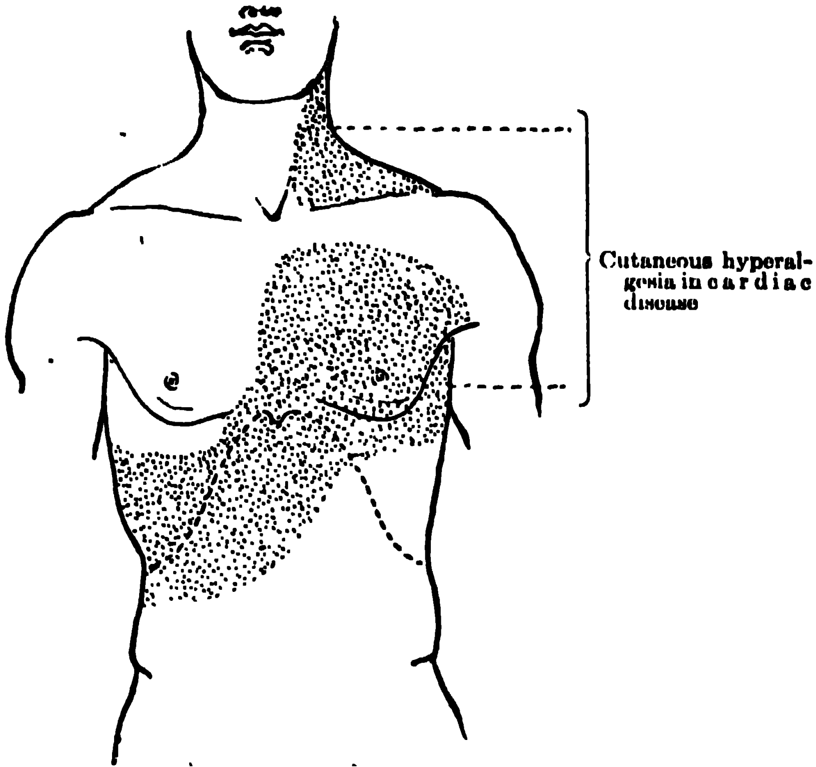


FIG. 178.—AREAS OF CUTANEOUS AND DEEPER HYPERALGESIA IN A CASE OF ACUTE DILATATION OF THE HEART, ACCOMPANIED BY ACUTE DISTENTION OF THE LIVER.

In some cases of heart disease there may also be present an area of hyperalgesia on the arm in the second dorsal segment and another over the heart in the fourth dorsal segment, as in Fig. 177, wherein the hyperalgesia was present on the chest, and also in a long narrow strip on the anterior surface of the arm. In this case the area of hyperalgesia most likely represented a disappearing zone of hyperalgesia. It is in cases of this kind that hyperalgesic zones are overlooked.

The hyperalgesia may sometimes extend into the right side or

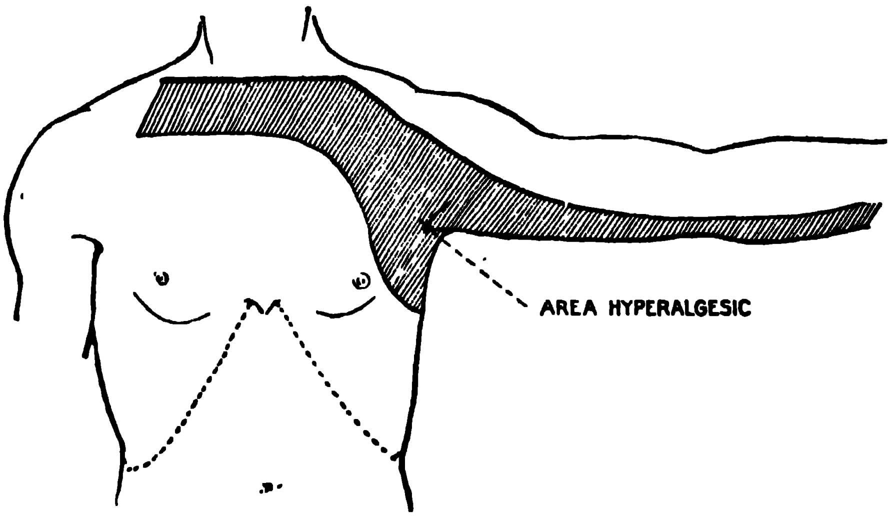
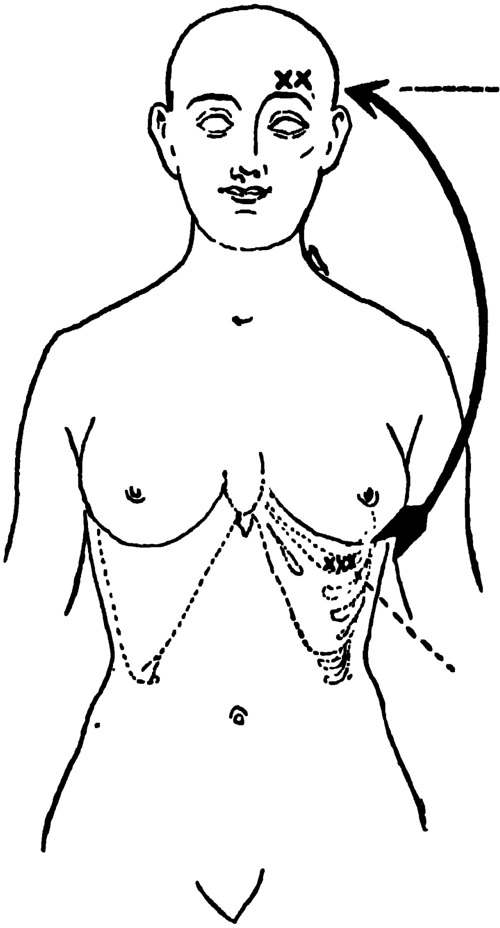


Fig. 179.—Hyperalgesic Area in a Case in Which the Myocardium is Probably in a State of Intoxication.

The heart rhythm is slightly irregular; at times the first sound is reduplicated, or, rather, instead of the normal first sound, there is a double first, with an absence of the second. The right side of the heart is also involved, a tricuspid regurgitant murmur being present.

up into the neck, as in the case of a negress (Fig. 179), who, after recovering from pneumonia, developed a delirium cordis with variable pulse and a slight tricuspid regurgitation. Since the right side of the heart and the great veins bear the greatest part of the stress of a tricuspid regurgitation in lesions of this character, the higher cardiac areas (the first and second dorsal) are most frequently affected, and can be taken as indicators of this condition. In this connection it is well to remember that the right ventricle of the heart, when diseased, is not so apt to produce pain as is the left ventricle; so that pain is not as prominent a diagnostic symptom of right heart involvement as it is of involvement of the left. In fact, the only symptoms complained of in disease of the right side of the heart may be a feeling of weight or pressure over the cardia, and a tendency to take strong, deep inspirations. In some cases the anatomical structure of the heart may be greatly deranged without causing any marked symptoms, as in one case, in which a column of fat one inch in diameter extended through the wall of the ventricle, and the only symptoms complained of were a slight shortness of breath and a feeling of weight in the pericardium. But, as a general rule, it



Area of sympathetic pain (from chest)

Areas painful to the touch. On making pressure at times over these spots a very severe pain was produced on the forehead in the left frontal region

FIG. 180.—AREAS OF PAIN IN A CASE OF MITRAL AND AORTIC REGURGITATION.

During the last few days previous to the time at which the outline was made, the heart had been acting very badly, and only the night previous to the outlining of the pain areas the patient had an attack resembling angina pectoris. At these times she also had pains referred to the labia on both sides with painful urination and retention of the urine. Examination of the urine and the urinary organs showed nothing abnormal.

DIFFERENTIATION BETWEEN ACUTE ENDOCARDITIS AND CHRONIC AND RECURRING ENDOCARDITIS

	ACUTE	CHRONIC
Fever.	Present.	Absent.
Hypertrophy (Heart).	Absent.	Present.
Murmurs.	Changeable in character—gradual increase in intensity, as the diseased process advances new murmurs may make their appearance.	Constant in character—presystolic murmur at apex and aortic murmurs are in favor of chronic endocarditis.
Secondary phenomena.	Emboli are carried to several organs and give rise to hemorrhagic infarcts in the 1. Brain. Hemiplegia. Aphasia. 2. Kidney. Bloody urine. Pain in the renal region. 3. Spleen. Pain. Swelling. 4. Lungs Hemoptysis. Circumscribed dulness, generally at the base of the lung. Dyspnea. These are generally ushered in by a chill; also sympathetic vomiting sometimes occurs.	Secondary phenomena are due to changes in the valve segments, etc., and manifest themselves as passive congestions (lungs, liver, etc.)
Blood.	Culture generally shows bacterial growth.	No bacterial growth on culture.

may be stated that acute inflammatory lesions of any part of the heart will produce reflex hyperalgesia in one or all of the cardiac zones of hyperalgesia.

This hyperalgesia is of considerable value as a prognostic sign in acute endocarditis. Its disappearance indicates the recession of the lesion and the return of the parts to the normal. However, it must be borne in mind that the absence of hyperalgesia does not positively indicate an absence of pathology in the heart, for the pathology may be of such a character that it may not produce any cutaneous hyperalgesia.

Cardiac pain may also in some cases be referred to distant areas, as in one case where it was referred to the head in the distribution area of the fifth nerve, being especially severe in the area of distribution of the supraorbital branch (See Fig. 180).

Dilatation of the heart is always painful, and causes hyperalgesia in the second, third, and fourth dorsal, and in the cervical regions, especially on the left side. The zones over the liver, the seventh, eighth, and ninth dorsal, are also painful (see Liver). This is due to the congestion of the liver which is always associated with a failing heart. Fig. 178 illustrates the point exactly.

The diagnosis between heart disease and intercostal neuralgia is sometimes difficult, but is made easier if the physician remembers that in intercostal neuralgia the pain is along the course of the intercostal nerves, while in cardiac disease it has no such distribution.

The differential diagnosis is as follows:

Cardiac Disease.	*Intercostal Neuralgia.*
Pain is in the cardiac zone areas.	No pain in the cardiac areas.
Movement of thorax is not especially painful.	Movement (respiratory, etc.) of thorax is painful.
Pain does not radiate around the chest, and the intercostal spaces are not tender.	Pain may radiate round the chest and is present on pressure in intercostal spaces.
Pain, when present, is more or less constant.	Pain is intermittent.
Pressure on area of tenderness will not produce a pain radiating around the chest.	Areas of tenderness are present, pressure on which will produce a pain radiating around the chest.

Intracardiac Lesions as Causes of Pain.—The *raising of the intraventricular tension* often causes cardiac pains. They generally occur after pronounced exertion, and are rather common in patients with arteriosclerosis who have a leaking aortic valve. A peculiarity worth noting is that, as soon as a mitral regurgitant murmur develops, and an outlet is provided for the increased intraventricular tension consequent to extra muscular effort, the pain disappears. *Mitral regurgitation* often causes a pain referred to the left shoulder and down the arm. Palpitation is a frequent accompaniment. The cause of this pain may be that early in, and, in fact, during the entire course, of the disease, the intraventricular pressure in the right ventricle is increased, the tension is raised, and as a result pain arises from the greater work thrown upon the heart. (This may occur only in stages of acute loss of compensation.)

Degeneration of the cardiac ganglia is given as cause of cardiac pain by W. H. Thompson, who speaks of cases wherein severe pain was felt in the cardiac region, with all the signs of angina; and yet, when death supervened during an attack, no apparent pathological abnormalities could be found. He suggested that a degeneration of the cardiac ganglia would probably account for the condition. (Degeneration of these ganglion could have been proved by careful microscopic examination.)

In some cases it is difficult to differentiate the pains of gastric origin from those due to cardiac disease.

The following differential diagnosis after Smith may be useful:

PAINS OF GASTRIC ORIGIN.	PAINS OF CARDIAC ORIGIN.
Appear after food, and apparently are the direct result of its ingestion.	Appear quite irrespective of whether food is taken or not.
Accompanied by feeling of fulness in stomach; often relieved momentarily by belching.	No such feeling of fulness; not relieved by eructation of wind.

Pains of Gastric Origin.	Pains of Cardiac Origin.
Not increased by active movements, such as walking.	Increased by active movements, which, owing to the severity of the pain, may even be impossible.
Heart sounds normal in rhythm and character.	As a rule, some cardiac bruit is present, or at least some alteration in rhythm and volume of pulse.

Because it is the most characteristic of the painful diseases of the heart, angina pectoris will next be separately considered.

ANGINA PECTORIS

Etiology.—Angina pectoris, which is the most painful as well as the most distressing lesion of the heart, is said to be due to the following:

(1) Anemia of the heart muscle, which in turn is the result of the narrowing of the coronary arteries. This narrowing may occur at their place of origin at the aortic valves; for instance, aortitis, with consequent sclerosis of the aortic valve, may occur, and lead to a partial closing of the coronary opening. The resulting pain is due to factors acting similarly to those which cause the pain in intermittent claudication. Any condition causing anemia of the cardiac muscle, such as exhaustion, bad health, non-assimilation, etc., in a person previously disposed, will frequently bring on this pain.

(2) Irritation of nerves in the heart wall. These nerves are of the sympathetic variety, and consequently do not carry direct pain stimuli, but only irritating ones, which are carried to the cord and from thence are referred to the periphery as pain.

(3) Exhaustion of the heart muscle from overwork causes pain. This pain is due to the same causes as the pain produced in the affected muscles after excessive muscular fatigue (Mackenzie).

(4) In addition to the above causes of cardiac pain, Mackenzie also claims that angina pectoris is due to a loss of contractability of the cardiac muscle fibers.

(5) However, the direct exciting cause in angina pectoris seems to be (a) psychic, the result of emotion, such as anger or extreme joy; or (b) physical overstrain, such as accompanies the lifting of excessive weights, running long distances, or the performing of long-continued exercises.

Bramwell (890) and Osler (892) seem to be somewhat inclined to the view that it is the physical strain which is the cause of the pain in angina pectoris, because it necessitates extra work by the ventricle, and, as a consequence, irritation of the cardiac nerves.

(6) Angina pectoris may also be due to a raising of the intraventricular tension in a weakened heart. The most frequent organic lesion of the heart producing angina pectoris is aortic regurgitation and stenosis, without an accompanying mitral lesion. When the intraventricular pressure is relieved by a mitral regurgitation the blood is thrown back on the lungs, and the pain ceases.

Pseudoanginal pain also occurs, and is frequently due to stomach disorders. The cord centers for the stomach are near the same level as the cord centers for the heart, consequently the reflected pain and cutaneous hyperalgesia for both occur in the same area, and one is apt to be mistaken for the other (Curtin, 891).

It seems that cardiac angina is often brought on by overeating, or by the eating of unsuitable or indigestible food, or food that is very apt to ferment, and thus cause dilatation of the stomach, which would press up against and inhibit the work of the heart.

Character of the Pain in Angina Pectoris.—In some the sensation may not reach the dignity of a pain, but is felt as a creeping or a formication under the skin, or, in other cases, as a tingling, or coldness of the skin surface. When it does approach the magnitude of a pain it becomes very severe; so much so that the suffering individual thinks his life is about to terminate. A definite characteristic of the pain of angina pectoris is that it almost always follows exertions, mental or physical.

Location of the Pain.—The pain may be felt directly over the heart; in the arms; in the chest as a girdle sensation; in the neck; in the gums and throat, or in the right side. Monro (32) mentions a case in which there was pain in the left eyebrow and in the right upper limb. This pain was accompanied by an intense desire to urinate. Osler mentions a case in which the pain was in the testicle.

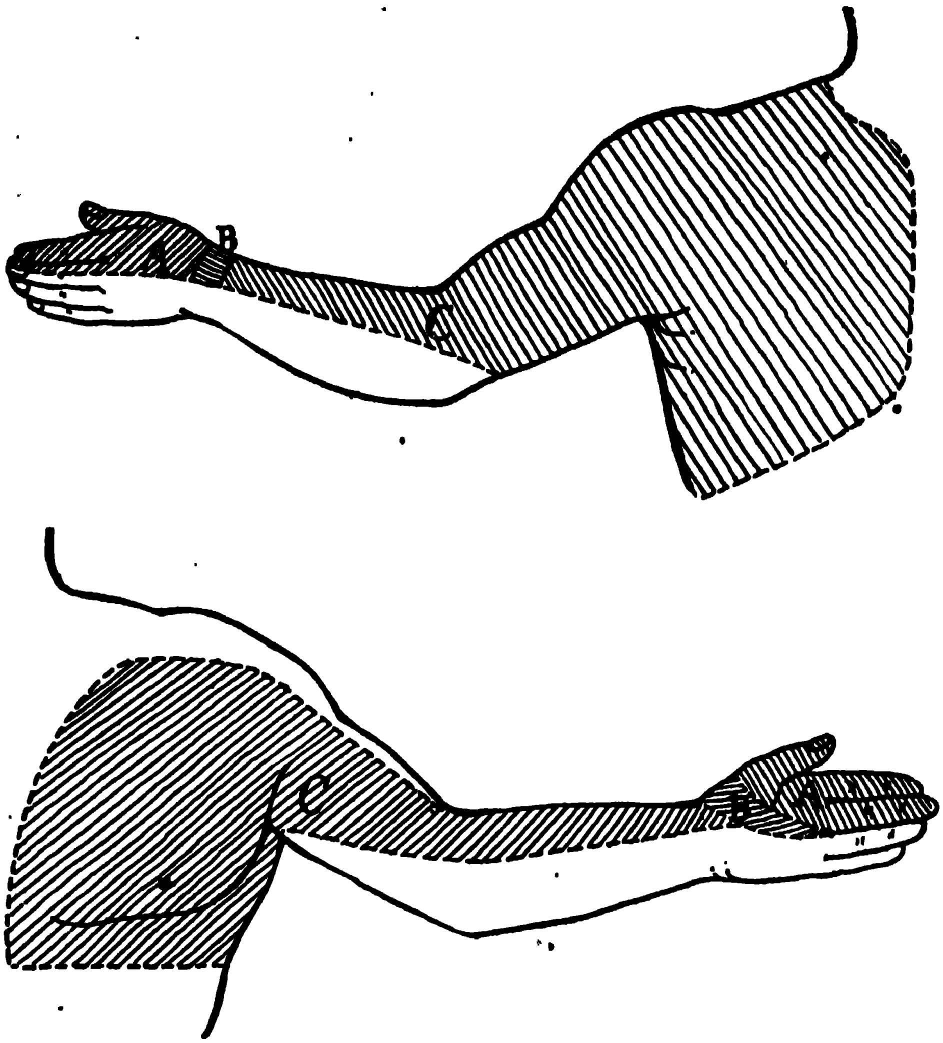


Fig. 181.—Area of Sensory Disturbances in a Case of Angina Pectoris. A, analgesia with anesthesia; B, analgesia without anesthesia; C, hyperesthesia. (From G. A. Gibson, 250.)

In some cases a pain equal in intensity to that usually felt over the heart is present in the arm and is entirely absent over the heart. It may start in the little finger or in the forearm, and gradually progress up the arm until it passes over the chest to the cardiac area, where it may remain. In other cases the pain may be felt in the chest in the cardiac area (third dorsal zone), and in the forearm in the first dorsal area, the remainder of the arm being entirely free of pain. In other cases the reverse is

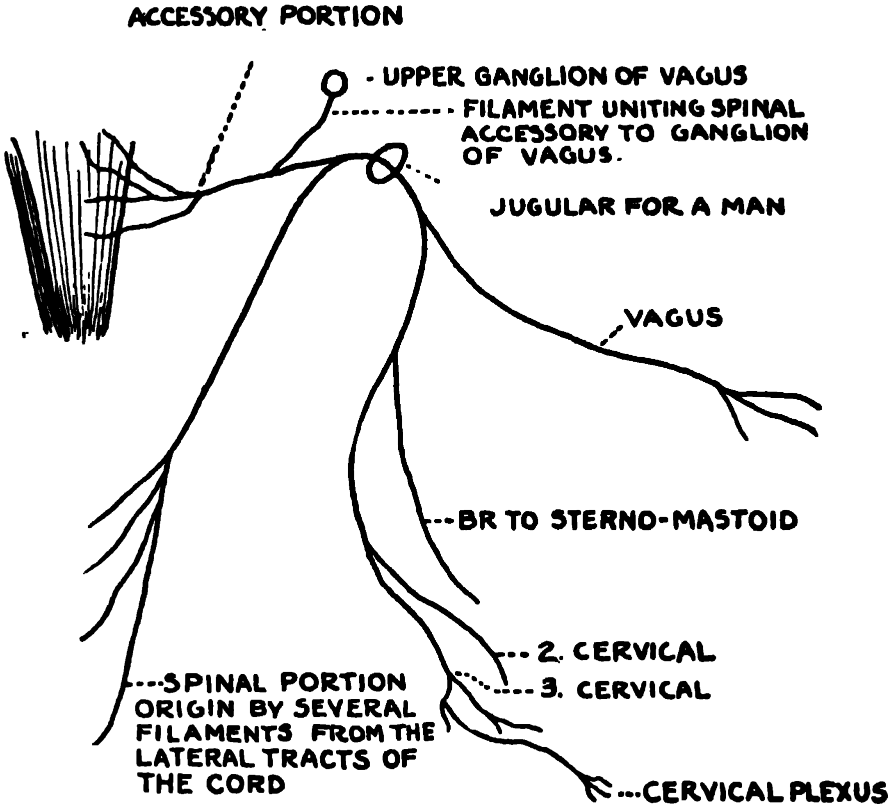

ACCESSORY PORTION
UPPER GANGLION OF VAGUS
FILAMENT UNITING SPINAL ACCESSORY TO GANGLION OF VAGUS.
JUGULAR FOR A MAN
VAGUS
BR TO STERNO-MASTOID
2. CERVICAL
3. CERVICAL
SPINAL PORTION ORIGIN BY SEVERAL FILAMENTS FROM THE LATERAL TRACTS OF THE CORD
CERVICAL PLEXUS

Fig. 182.—Communication between Spinal Accessory and Vagus. The tender spot at the point of emergence of the spinal accessory from the sternomastoid (in cardiac disease) is probably due to the close association between the accessory and the upper ganglion of the vagus.

true, the pain being present in the cardiac area on the chest and absent elsewhere. In nearly all these cases there is a peculiar constricting sensation around the chest, as though the body were wound with a rope drawn so tightly that breathing was inhibited. The cause of this sensation is the spasmodic contraction of the intercostals, such contraction being explained by the hypothesis of a visceromotor reflex. In cardiac disease pain may also be felt in the trapezius and the sternomastoid, and in the skin overlying these muscles. This pain can be accounted for by the close relationship of the vagal centers in the medulla to the centers of the sensory nerves supplying the trapezius and sternomastoid muscles, so that an irritation of the vagal centers will produce an irritation of the sensory centers supplying the trapezius and sternomastoid and overlying skin, and, as a consequence, pain will be perceived in this area (Mackenzie). In still other cases pain has been felt in the gums and throat. It may even be located on the right side of the body, and may appear on the left side only late in the disease, or not at all. According to Hoover, the pain in the neck is in the distribution area of the third cervical segment.

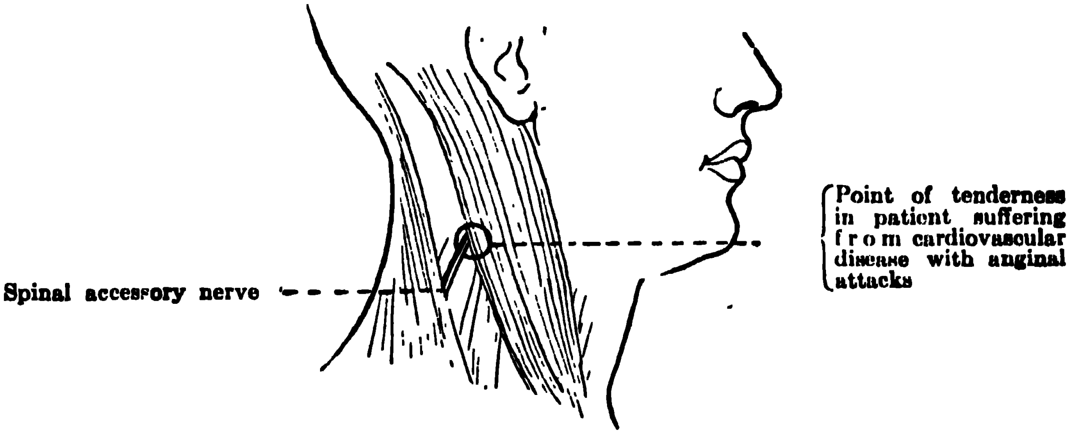

Point of tenderness in patient suffering from cardiovascular disease with anginal attacks
Spinal accessory nerve

FIG. 183.—EMERGENCE OF THE SPINAL ACCESSORY FROM UNDER THE STERNOMASTOID.
This is the point where local tenderness is frequently present in cardiac disease.

Local Tenderness.—In angina pectoris local tenderness is present at a point on the border of the sternomastoid, where the spinal accessory becomes superficial, and is also present over the second and third ribs, about one inch external to the left sternal line (Hoover).

Associated Symptoms.—The symptoms associated with angina pectoris are: increase in the flow of the urine and saliva, an increased arterial pressure, shock (indicated by pallor, etc.), dilatation of the pupils, and absolute inability to undergo any physical or mental work during the time of the attack. The feeling of approaching death is frequent. The termination of the attack may be announced by the expulsion of the air which has been drawn unconsciously into the stomach during the attack (Mackenzie).

Myocarditis is generally free of pain, though exertion is frequently followed by pain and dyspnea.

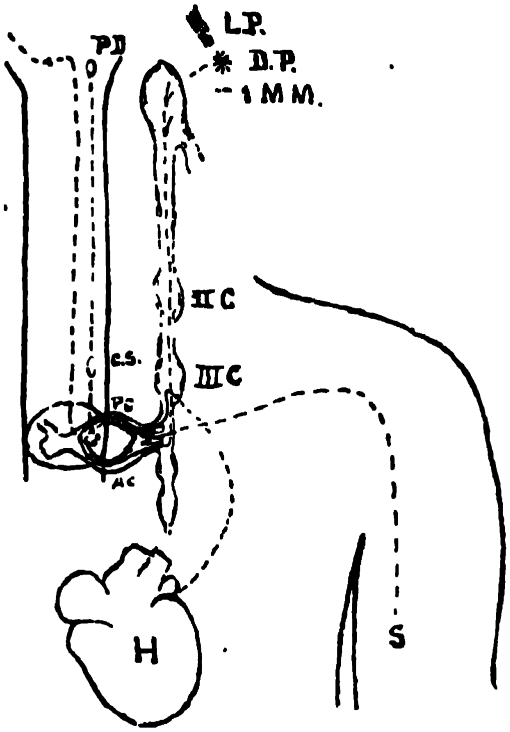


FIG. 184.—CONDUCTING PATHS FOR IMPULSES FROM THE HEART. The figure shows the relationship existing between the heart, the pupillary reactions, and the radiation into the arm. DP, the pupil dilating center in the base of the brain; DP, radiating fibers of the iris; MM, muscle of Muller; LP, non-striped portion of the levator palpebræ; S, indicates the method of radiation into the arm. (Copied)

DISEASE OF THE PERICARDIUM

In disease of the pericardium pain may be entirely absent. When present it is located in one of the areas of reflected cardiac pain. A characteristic of pericardial disease, not so frequently present in heart muscle or endocardial involvement, is that tenderness is marked over the cardiac area, especially so should a mediastino-pericarditis be present. In this condition, where the inflammation lies so close to the chest wall, pain and tenderness are present over the third rib on the left side, and extend about one to two inches from the left sternal border. This is also the area which Hoover gives for tenderness in angina pectoris, and which Head gives for the maximal tenderness in the third dorsal zone (anterior). This accord is wonderful when it is considered that the location of these areas has been worked out from different premises, Head's area being considered as the result of a stimulus acting reflexly through the cord, while Hoover's areas are regarded as the places where the local tenderness is most marked.

The tenderness of the skin and subjacent tissues in pericarditis extends for a considerable distance lateral to the right sternal margin. The pericardium of itself is insensitive to all ordinary stimuli, as Richeraud has claimed and as many others have found (during operations).

CHAPTER XXXV

THE RESPIRATORY ORGANS

THE LUNGS

GENERAL

Etiology of Lung Pain.—Pain in the segmental areas associated with the lungs may be the earliest indication of a pulmonary involvement, though in many cases there may be no actual pain manifestation, but only a feeling of discomfort in the chest wall. It seems that pain is not as common in lung disease, with the exception of pneumonia, as it is in disease of the heart. When it is present many causes are assigned, the principal one being an inflammation of the pleura. That this is a very important factor in the production of lung pain can hardly be doubted, in view of the almost universal association of a pleurisy in those lung diseases in which pain is a prominent symptom. Yet the visceral pleura of itself has very little sensation, as can be demonstrated during the removal of a pleural exudate, when, should the pleura come in contact with the tip of the cannula, no pain results. Mackenzie says that in several cases he has made careful dissections of the intercostal nerves, following them to their terminations, and that in no case could he find "a single filament going to the pleura." He suggests that the referred pain of basal pleurisy may be due to the invasion of the diaphragm by the inflammation.

Distribution of Referred Pain.—If such is the cause, the pain of pleural disease must be produced in the parietal subjacent pleural tissue, and be carried through some of the branches of the intercostal nerves, which, though not directly connected with the pleura, are found ramifying in the subpleural connective tissue (Johnston, 538). If this were so we should expect to find pleural pain referred to the points of maximum tenderness of the intercostal nerves; that is, to the points where the nerves become superficial. Now, if we examine a case of pleurisy, with pain production, we find that this is true, the pain due to pleural lesions being most often felt in the anterior axillary line, which corresponds fairly well with the line of the points of emergence (areas of greatest tenderness) of the intercostal nerves. However, because of the close relationship of the parietal and visceral pleura it is almost impossible for one to be diseased without the other being affected, so that we always find both taking part in the inflammatory process.

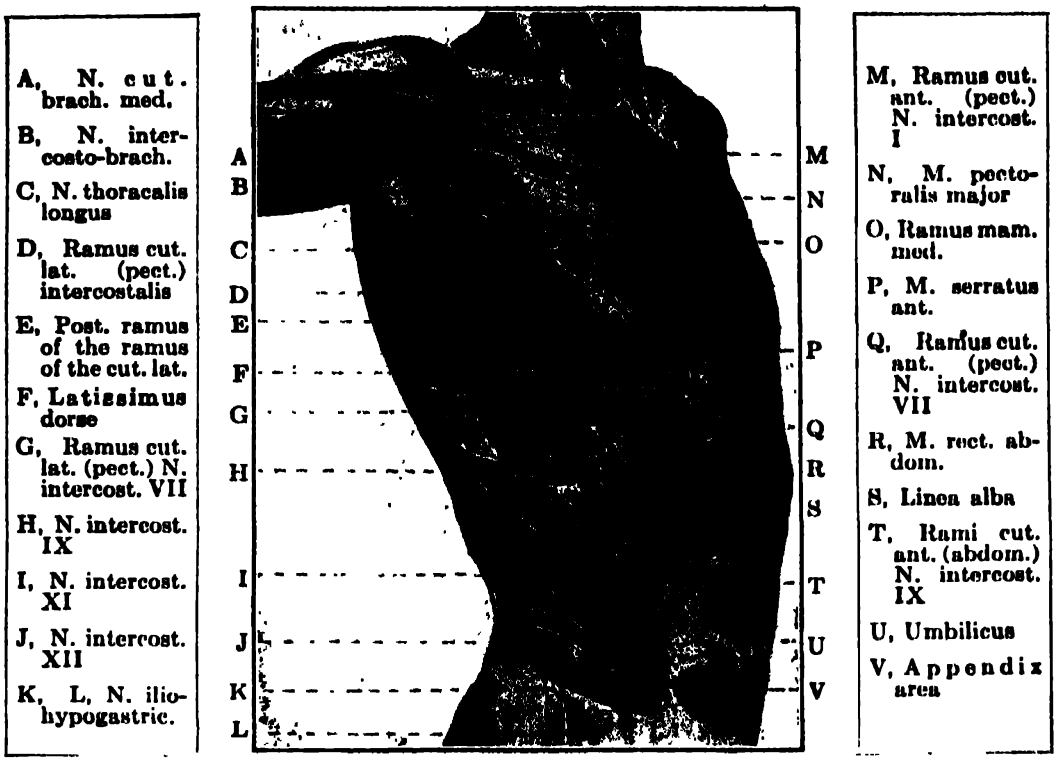


FIG. 185.—POINTS OF EMERGENCE OF THE DORSAL NERVES (ANTERIOR). These points are, as a rule, the places where pain is complained of when the thoracic nerves are irritated. Generally, tenderness is also present in the skin immediately over these areas. (Spalteholz, Leipzig, 1909, vol. 3.)

When the parietal pleura is inflamed it is very easy for the inflammatory process to spread and involve the intercostal nerves, and thus cause an intercostal neuritis. Should this occur, tenderness is present in the intercostal spaces, is most marked at the anterior axillary line, and extends out onto the anterior wall of the chest. Pain is also felt in this area, but lies more toward the sternal margin. When the lower part of the pleura is involved respiration becomes very painful. This is due to the constant friction of the parts, and the slight pressure and traction made upon the supersensitive intercostal nerves during each respiratory act.

Pain due to inflammation of the visceral pleura is not direct, but is referred, through the sympathetic nervous system, to the cord, and thence back to the chest wall through the spinal nerves. This reference pain is located in one or more sharply defined areas, the so-called Head zones.

The zones in relation with the lungs or pleura are those of the first seven dorsal segments of the cord. The maximum points of tenderness of these zones are the places where the patient frequently feels the most severe subjective pain. That all these zones are involved to an equal degree in disease of the lung or pleura cannot be held. Indeed, it seems more than likely that the only zone almost constantly involved, either in visceral pleural disease or in disease of the lung itself, is the fourth dorsal, which has its area of maximum tenderness slightly above and external to the nipple, the point where the patient complains of the greatest pain. How true it is that the physician often sees cases which begin with a chill, followed shortly by a rise of temperature and an increase of pulse rate, and which, with the exception of a cough, have no sign of lung involvement, except the pain in the chest above and external to the nipple! And yet after two or three days typical signs of pneumonia appear. To those who are not aware of the relationship of pain and pulmonary disease it is surprising to find that the area of greatest pain does not always correspond with the location of the lesion; yet, from our previous knowledge, it is easy to explain this apparently erratic reference.

If, on careful examination, no pleural friction rub or other sign of pleurisy at the place where the pain is felt can be found, how, otherwise, in the absence of other symptoms, can this chief pain be accounted for, except under the hypothesis that through the sympathetic stimuli are carried to the cord, and are thence referred back to the body walls through the somatic nerves and are there perceived as pain?

A serous pleurisy of considerable magnitude may exist without giving rise to the slightest pain. This has been exemplified in many cases. They were all the result of chronic disorders, and were associated with a backward stasis from a failing heart. In acute pleurisy pain is always a prominent symptom.

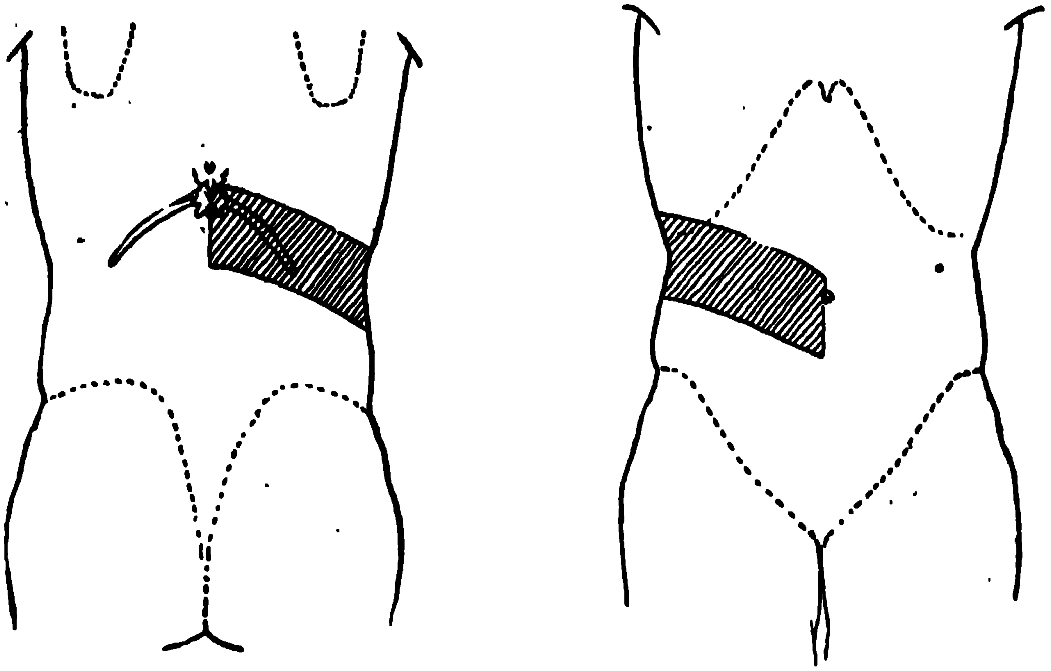
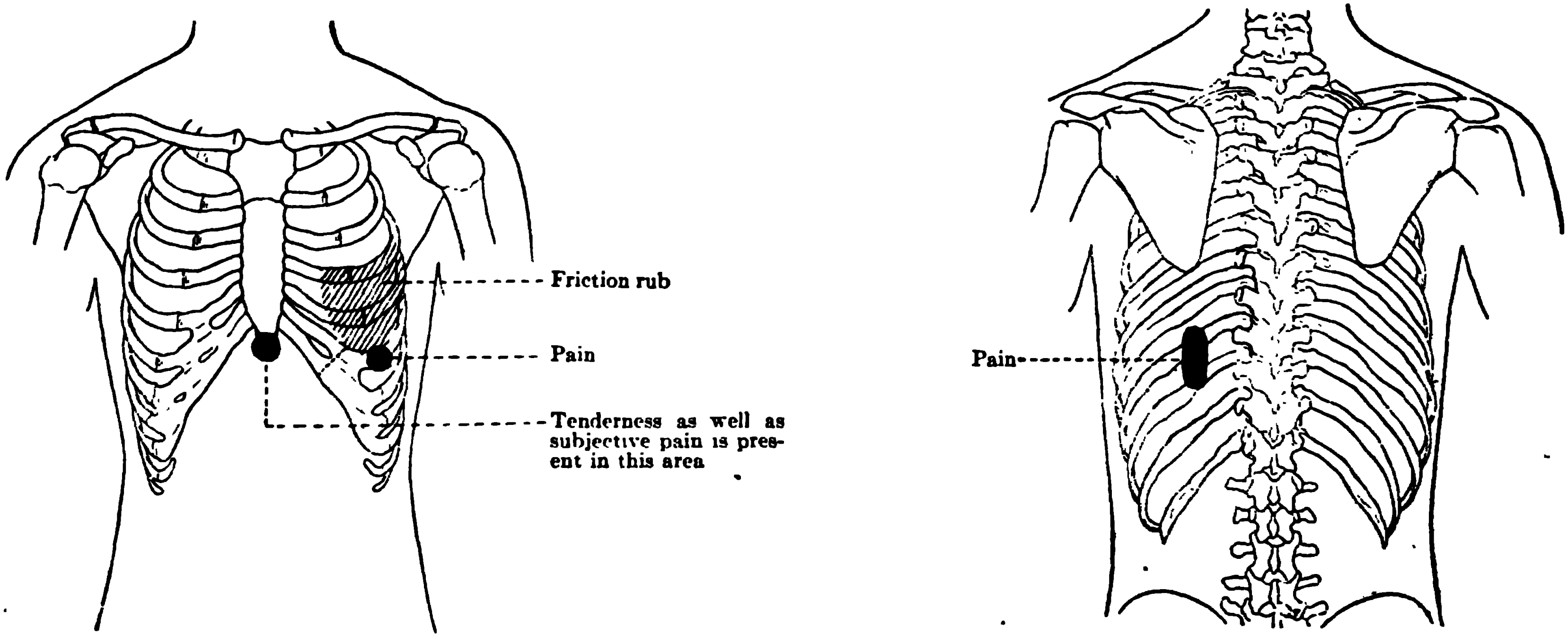


FIG. 186.—AREAS OF HYPERALGESIA IN A CASE OF DIAPHRAGMATIC PLEURISY.

In inflammation of the pleura, over the diaphragm and adjacent to the mediastinum, the phrenic nerve may become irritated. When this occurs the irritation is conveyed to its center; and since, according to Van Gehuchten, the phrenic conveys sensory fibers, the stimulation may be felt as coming from its peripheral distribution in the diaphragmatic, pericardiac, and costal pleura.

If the diaphragm alone is involved in the pleurisy the pain is conveyed through the tenth, eleventh, and twelfth thoracic nerves, and is referred to their area of distribution in the lower abdominal wall.


Friction rub
Pain
Tenderness as well as subjective pain is present in this area
Pain

FIGS. 187 AND 188.—AREAS OF REFERRED PAIN IN PLEURISY. The areas of pain are in the maximum points of tenderness of the 7th and 8th dorsal zones of Head.

Of these the tenth is the nerve most frequently involved. The pain is of a characteristic dull, aching type. It may be stated as an aphorism that as a rule only acute diseases of the lung and pleura produce pain, and that chronic diseases are painless.

DISEASES OF THORACIC ORGANS CAUSING PAIN

The acute diseases most commonly producing thoracic pain are: lesions of the pleura, as acute inflammation, empyema, adhesions (diaphragmatic, costal), and diseases of the lungs, which are: acute bronchitis, pneumonia, and tuberculosis. Pain, as a rule, is not a prominent symptom in the following chronic diseases: chronic bronchitis, bronchiectasis, asthma, emphysema, chronic tuberculosis, chronic pleurisy, hydrothorax, and new growths, either of the lung or of the pleura.

Acute bronchitis, localized exactly in the bronchi, causes pain, which is referred to the same somatic areas as is the pain of parenchymatous pulmonary disease.[1] But since all cases of bronchitis involve the trachea to a greater or less degree, the pain is felt also in the area of distribution of the nerves supplying this organ. These nerves are the pneumogastric with its recurrent branches and the sympathetic. It is evidently the referred sensation from the trachea through the sympathetic to the skin of the neck and the upper part of the chest that is the cause of the aching and soreness in these regions, complained of so much in tracheitis and bronchitis. A pain in the lower part of the thorax, or in the upper part of the epigastrium, is also present at times in bronchitis. This pain is the result of the traction and pull on the ribs and costal cartilages made by the abdominal muscles and the diaphragm in the act of coughing. It is present only in severer forms of bronchitis, which are accompanied by considerable coughing. As bronchitis is often but a localization of a generalized infection, pains due to this infection may at the same time be present in other parts of the body. These pains are due to the general toxemia, and are not caused by the bronchitis,

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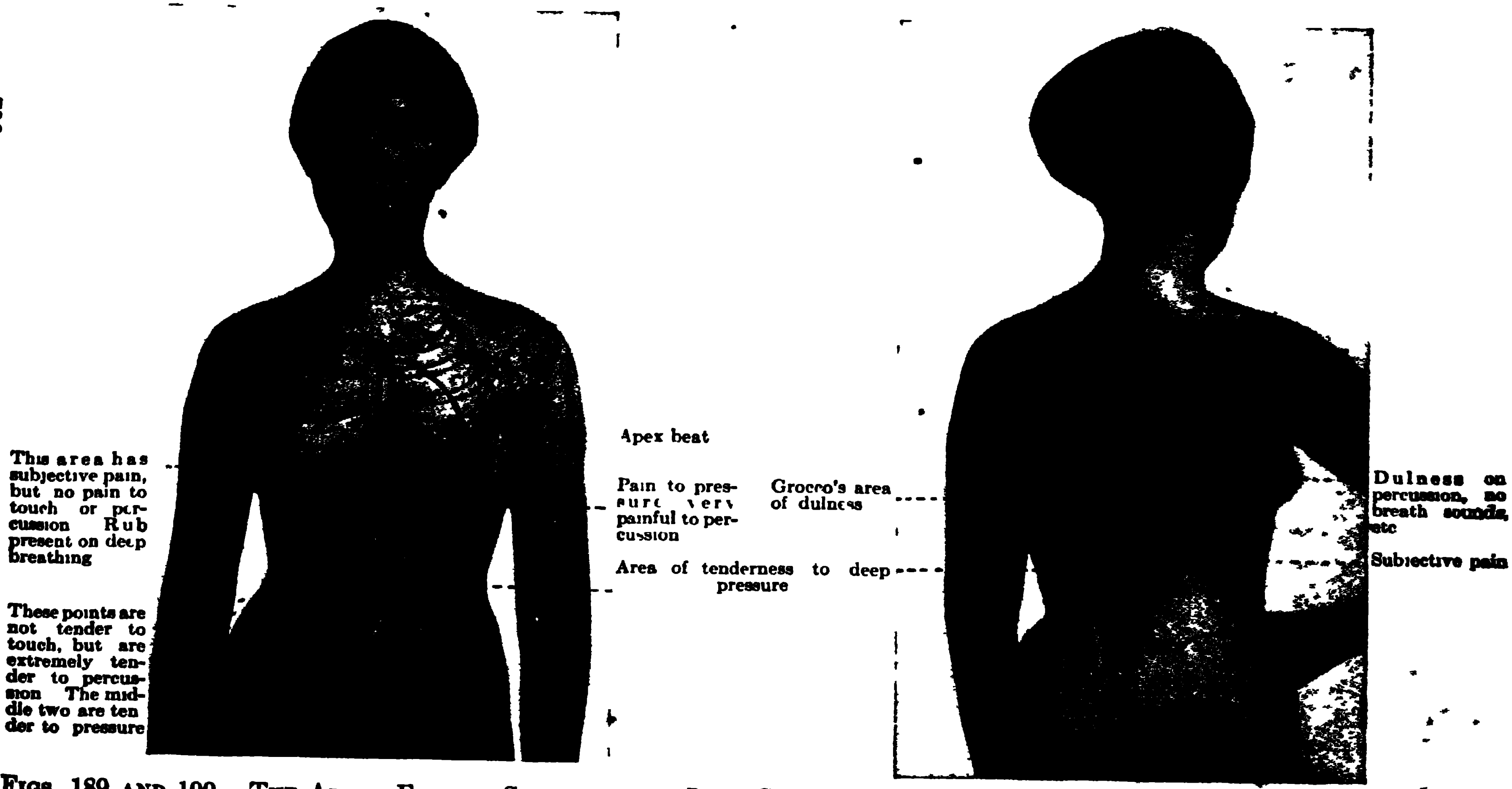
[1] Head gives the second dorsal visceral segment as related to bronchial disease.



This area has subjective pain, but no pain to touch or percussion. Rub present on deep breathing

These points are not tender to touch, but are extremely tender to percussion. The middle two are tender to pressure

Apex beat

Pain to pressure very painful to percussion

Grocco's area of dulness

Area of tenderness to deep pressure

Dulness on percussion, no breath sounds, etc

Subjective pain

FIGS. 189 AND 190.—THE ABOVE FIGURES SHOW, ON THE LEFT SIDE, THE AREAS OF DISTRIBUTION OF PAIN IN A CASE OF DIAPHRAGMATIC PLEURISY WITH EFFUSION; ON THE RIGHT, THE AREAS BEFORE THE EFFUSION APPEARED.

Pain is present in the right side of the chest above the nipple in the nipple line. At this point the patient also had pain on breathing. At first she could lie better on the left side, but at the time the drawings were made she could lie best on the right side. On breathing, at the present time, she has pain in the places indicated in the figures.

which, in the general involvement, is but a factor. Chronic bronchitis is without pain-phenomena. When pain is present it is due either to a myalgia or an intercostal neuralgia.

Pneumonia.—Pneumonia practically always is productive of pain. Even the so-called central pneumonia causes pain. The pain of pneumonia varies. In some cases it is an aching and a dragging felt in the fourth dorsal visceral zone, while in others it extends up into the first, second, and third dorsal zones. It may also, according to Head, be found in the fifth, sixth, and seventh dorsal zones. Owing to the co-association of these lower cord zones with the lungs, the liver, and the stomach, lesions of the lungs frequently give rise to hepatic and gastric symptoms, and cause some confusion as to which of these organs is involved. In involvement of these zones the pain is frequently felt in the epigastrium or low down on the same side of the chest as the lesion. There are also present in these zones maximal points of tenderness, in which pain is felt subjectively by the patient, and in which the skin is exquisitely tender to the touch. It is in these areas of maximum tenderness that pain is often referred in pneumonia. In central pneumonia these areas of pain may be the only indications (in the early stages) of the pneumonic involvement. Other forms of pneumonia are generally associated with a pleurisy, and the pleurisy generally monopolizes the pain syndrome to such an extent that the pain of the pneumonia proper is overlooked. When pleurisy is present tenderness may be marked over the diseased area, so that, therefore, the associated pleurisy in pneumonia may give rise to pain felt either locally or referred to the abdomen (iliac region). This latter has been mistaken for appendicitis pain. This probably occurs only when the diaphragm is involved in the inflammatory process, in which case the twelfth intercostal nerve is irritated, and the stimulus is perceived as coming from its terminal filaments, which are distributed over the area usually associated with appendix disease. A reference of this kind frequently takes place in children, and when associated with abdominal rigidity, chills, elevation of temperature, and a rapid pulse is apt to lead to the diagnosis of appendicitis. This is all the more likely when, as in many cases, the signs of the pneumonia do not appear until twenty-four to forty-eight hours after the onset of the disease.

Janeway, Osler, Frantzel, Cozolina (492), Barnard, Hampelin, Brewer, Richardson (491), Massalong (490), Lovett (494), Ginnon (493), Comby and Zielenski (495), all report cases of this character. Yet a mistake of this kind is almost inexcusable, for in nearly all of these cases, upon a thorough examination, signs of disease may be found in the thorax. In pneumonia, also, the rusty sputum, expiratory grunt, cough, rapid respiration which is out of all proportion to the pulse (respiration may be forty to sixty and the pulse only a hundred to a hundred and ten), and sudden, high elevation of temperature clearly point to the correct diagnosis. Another diagnostic sign of value is, that, in those cases in which the lung is diseased, there is noticed a slight reduction in the rigidity of the abdominal wall at the beginning of inspiration. This is not present in cases of abdominal inflammatory disease. The abdominal wall in pneumonia also is sensitive to superficial pressure and insensitive to deep pressure. Rings are absent from around the eyes, and a flushing of the cheek on the affected side is generally seen.

In reference to the confusion of these two diseases, Rodman, in a discussion on referred pain before the Pennsylvania State Society, said that everyone, perhaps, has made mistakes in diagnosing pneumonia as appendicitis. He spoke of one case, a man with an acute pneumonia, in whom pain in the abdomen was the most prominent symptom. He was asked to see the case as one of appendicitis, and concurred in the diagnosis. He was also impressed with the fact that the man had a beginning pneumonia, and declined to operate, believing that the patient's chances would be best subserved by carrying him through the pneumonia and operating for the appendicitis afterward. Another physician who was called in did not concur in this opinion, especially as the abdominal symptoms increased in severity, and as the pain was very severe and did not yield to a large hypodermic injection of morphin. An operation was performed, and the appendix was found to be practically normal.

A case of referred pain in pneumonia was reported to me by McFarland. It was of a child, four years of age, in whom the pain was over McBurney's point. Signs of consolidation were present at the base of the posterior part of the right lung.

In another patient, suffering from bronchopneumonia, the pain complained of was half way between the xiphoid cartilage and the umbilicus.

In these cases of referred pains the diagnosis is all the more difficult should the pneumonic lesion be centric, though from the absence of local abdominal tenderness and the freedom from vomiting, etc., with the presence of rapid respiration, increased pulse rate, and coughing, the lungs should be considered as at fault, and a most searching examination made.

One differentiating characteristic between abdominal disease and pneumonia with referred abdominal pain is that, in the pneumonia, the skin over the painful area is very hypersensitive, but deep pressure can be made over it without causing much pain; while in appendicitis both superficial and deep pressure are very painful. Another characteristic of pneumonia is that the abdominal pain disappears as the pulmonary signs become more pronounced (Hood, *Lancet,* 1905).

The pain of pneumonia may also be felt in the neck and shoulders. In some cases it may be transferred entirely and be felt on the side of the chest opposite to that of the lesion. Such a transference is very common in infants. In infancy, pain is of doubtful value in making a diagnosis, because of its irregular location and frequently late appearance, for in many cases it does not appear until from three to five days after the onset of the disease.

In some patients the pain present during pneumonia persists for long periods, after all the physical signs of the disease have disappeared. This continuance in the majority of cases is due to fibrous changes in the lung, or to adhesions. In a case of Anders, pain in the cardiac region, persisting for four months after the crisis, was shown, by the Röntgen rays, to be due to a fibrous band stretching between the diaphragmatic pleura and the pericardiac sac.

Tuberculosis.—In the early stages of tuberculosis, during ulcer formation, pain is not so likely to be present as during the later stages, after an abscess has formed. At this later date, also, a pleuritis is more likely to be present, especially so if the tubercular lesion is in the apex. It is for this reason that pain in the supra- and infraclavicular regions is so often an early sign of pulmonary tuberculosis. During the second stage of tuberculosis the whole half of the chest on the affected side has a tired, aching feeling, not increased on deep breathing. It is during this stage, also, that pain is often a prodrome of hemoptysis. The reason for this may be that, prior to the hemorrhage, the lung, as the result of increased arterial tension, is in a state of congestion, and this gives rise to pain. After the hemorrhage the congestion is relieved and the pain disappears. Coughing, likewise, possibly for the same reason, frequently increases the pain. The pain most commonly associated with coughing is localized to the area of insertion of the recti muscles into the costal borders. In some cases of pleurisy the inflammation spreads to the intercostal nerves and a neuritis develops; the pain is now felt over the lateral and anterior parts of the chest. The branches joining the nerves of the arm to the second and third intercostal nerves may also become involved, and then the pain runs down the inner side of the arm, in the area of distribution of the nervi intercostobrachiales (intercostohumeral nerves).

Character of the Pain in Pulmonary Tuberculosis.—In some cases there may be only a sense of discomfort or a feeling of distress in the chest, while in others actual pain may be present. In many there is a sensation as though the pain extended all the way through to the back. It may be constant or fleeting.

Tenderness is a marked feature of early pulmonary tuberculosis; and, according to Francke, appears before many of the other symptoms. Tenderness is elicited by percussion, and is most marked in the apex. It is probably due to involvement of the subjacent pleura. This percussion pain Francke found present in about 77.9 per cent. of all cases of pulmonary tuberculosis. When search for this percussion is to be made high up over the back, the anterior fibers of the trapezius are displaced to one side, by

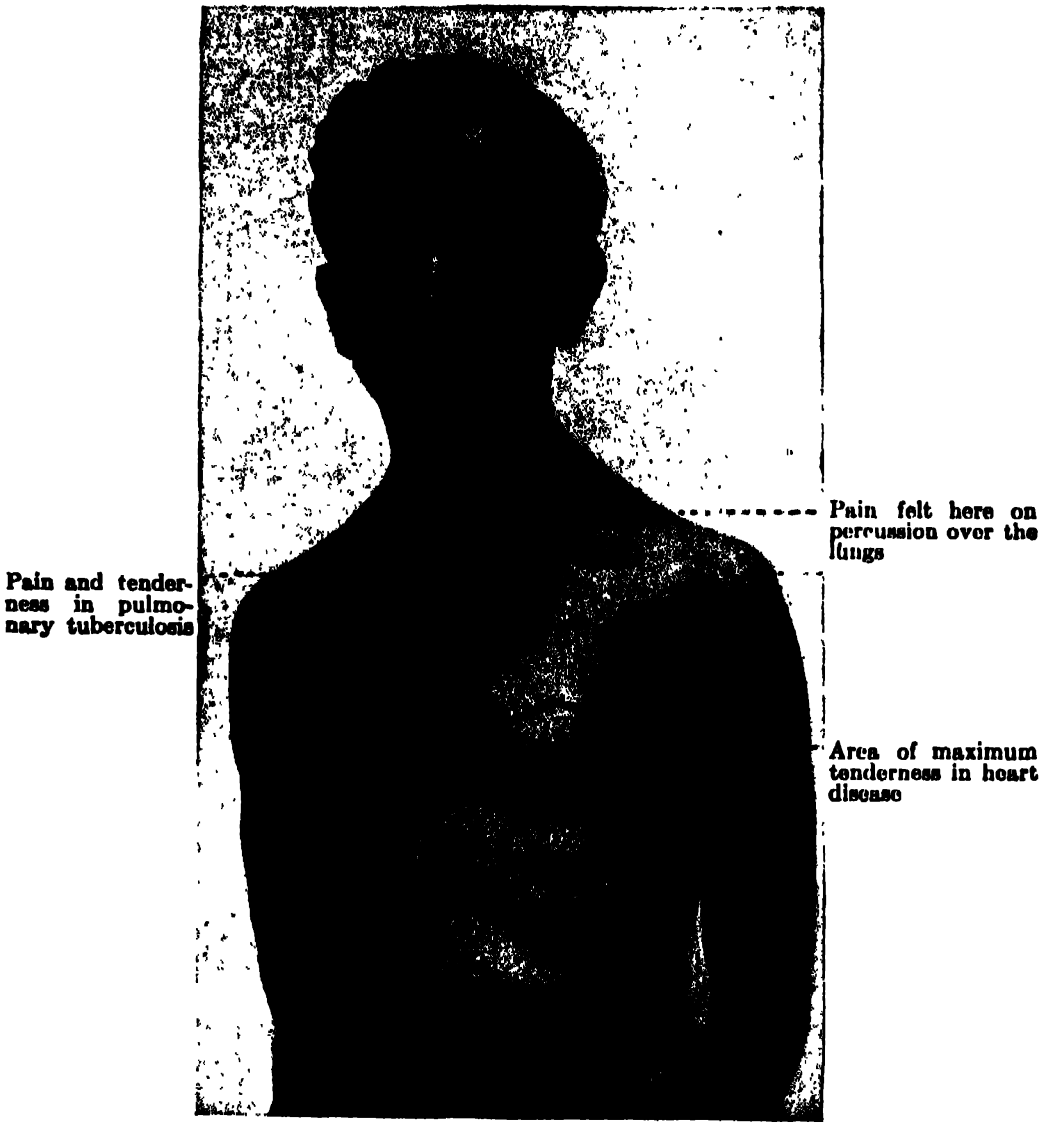

Pain felt here on percussion over the lungs
Pain and tenderness in pulmonary tuberculosis
Area of maximum tenderness in heart disease

FIG. 191.—SOME OF THE AREAS OF PAIN AND TENDERNESS IN CARDIAC AND PULMONARY DISEASE.

having the patient bend forward and fold his arms, so that the percussion blows may be made as directly as possible over the chest.

According to Klebs, in pulmonary tuberculosis tenderness is very common above the clavicles, anteriorly and posteriorly, and between the scapula posteriorly. A pain above the shoulder is felt with each cough, and pain on every movement of the arm may be present and is often mistaken for rheumatism.

Other causes of thoracic pain in pulmonary tuberculosis may be myositis, nervous erethism, pulmonary congestion, pressure from enlarged glands, localized fatigue of the muscles used in respiration or in coughing, contraction of old cavities, traction by adhesions to pleura or to the heart, pneumothorax, tuberculosis of the ribs, and referred pain.

The intercostal muscles may also become involved in the inflammatory process, and intercostal myositis may develop. The muscles are now extremely painful to touch or to movement, and, owing to the pain, respiration is restricted.

If a pleurisy has ensued during the lung involvement, and adhesions have formed between the pleura and the pericardia, pain results. This may be felt both during respiratory movements and cardiac contractions; in fact, it is pathognomonic of this variety of pain that it has an alternating character, due to the variation of pressure from the changed relationship of the heart to the surrounding tissues. Pressure over the places where traction is made upon the chest wall by the adherent pericardium and pleura is painful.

When during tuberculosis a pneumothorax results, a sudden, agonizing pain is felt. This may be so severe that it resists all medication, even morphin. It is said by Clement that pronounced neuralgia, marking the onset of tuberculosis, is a very grave prognostic symptom. L. Brown claims that a stubborn pain, when coincident with a poor general condition, chills, and fever, is frequently an indication of a deep focus which is extending toward the periphery of the lung.

THE MEDIASTINUM

The mediastinal diseases causing pain are aneurysm, mediastinal inflammation, abscess, and enlargement of the mediastinal glands. The pain complained of is both local and referred. The local pain is due to the pressure of the growths on the surrounding structures, which, in turn, causes pressure on the anterior chest wall and pain production. The referred pain is due to involvement of the nerves in the diseased process. Pain is common in the epigastrium, and may be present in the early stages. Pain may also be present in the back. In one case of mediastinal sarcoma it was present on each side of the chest over the scapulæ. In some cases of mediastinal tumors, especially in those of a malignant nature, the pain is due to an intercostal neuralgia, the result of infiltration of the intercostal nerves by the tumor cells. *Aneurysm of the arch of the aorta*, or of the thoracic aorta, causes but few painful symptoms except those due to pressure. When the aneurysm extends and lies just beneath the sternum, and begins to push its way through, causing necrosis of the bone, a boring, gnawing pain is felt. At this time marked tenderness over the diseased area is present. The esophageal pains have been described under the esophagus (q. v.).

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